PALÆONTOGRAPHICAL SOCIETY.

VOL. XLVIII.

JURASSIC GASTEROPODA.

PART I, NO. 7.

GASTEROPODA OF THE INFERIOR OOLITE.

PAGES 325—390; PLATES XXVII—XXXII.

CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

PART I.

CARBONICOLA (ANTHRACOSIA).

PAGES 1—80; PLATES I—XI.

INFERIOR OOLITE AMMONITES.

PART IX.

PAGES 377—456; PLATES XCIII—CIII.

FISHES OF THE OLD RED SANDSTONE.

PART II, NO. I.

THE ASTEROLEPIDÆ.

PAGES 63—90; PLATES XV—XVIII.

ISSUED FOR 1894.

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VOLUME XLVIII.

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ISSUED FOR 1894.

NOVEMBER, 1894.

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AND

I. A CATALOGUE OF THE WORKS ALREADY PUBLISHED;

II. A CLASSIFIED LIST OF THE MONOGRAPHS COMPLETED, IN COURSE OF PUBLICATION, AND IN PREPARATION, WITH THE NAMES OF THEIR RESPECTIVE AUTHORS;

III. THE DATES OF ISSUE OF THE ANNUAL VOLUMES;

IV. A GENERAL SUMMARY, SHOWING THE NUMBER OF THE PAGES, PLATES, FIGURES, AND SPECIES IN EACH MONOGRAPH;

V. A STRATIGRAPHICAL LIST OF THE BRITISH FOSSILS FIGURED AND DESCRIBED IN THE YEARLY VOLUMES.

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§ I. CATALOGUE OF WORKS

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY:

Showing the ORDER *of publication; the* YEARS *during which the Society has been in operation; and the* CONTENTS *of each yearly Volume.*

Vol. I. Issued for the Year	1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood, 21 plates.
„ II. „	1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell, 38 plates. The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards, 9 plates.
„ III.* „	1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones, 7 plates. The Permian Fossils, by Prof. Wm. King, 29 plates. The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen, 18 plates. The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime, 11 plates.
„ IV. „	1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood, 12 plates. The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett, 15 plates. The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson, 13 plates.

* The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils;' the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF WORKS—Continued.

Vol. V.	Issued for the Year 1851	The Reptilia of the Cretaceous Formations, by Prof. Owen, 39 plates. The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime, 19 plates. The Fossil Lepadidæ, by Mr. Charles Darwin, 5 plates.
„ VI.	„ 1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson, 2 plates. The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson, 5 plates. The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson, 5 plates. The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards, 6 plates. The Radiaria of the Crag, London Clay, &c., by Prof. E. Forbes, 4 plates.
„ VII.	„ 1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime, 10 plates. The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson, 9 plates. The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe, 10 plates. The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett, 8 plates. The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood, 8 plates. The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen, 9 plates.
„ VIII.*	„ 1854	The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous, with Appendix and Index to Vol. I, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen, 20 plates. The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett, 7 plates. The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime, 16 plates. The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin, 2 plates. The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe, 6 plates. The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards, 8 plates.
„ IX.†	„ 1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood, 11 plates. The Reptilia of the Wealden Formations, Part III, by Prof. Owen, 12 plates. The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards, 4 plates. The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe, 11 plates. The Tertiary Entomostraca, by Mr. T. R. Jones, 6 plates. The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright, 10 plates.
„ X.	„ 1856	The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright, 12 plates. The Fossil Crustacea, Part I, London Clay, by Prof. Bell, 11 plates. The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson, 4 plates. The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Wealden Formations, Part IV (Supplement No. 1), by Prof. Owen, 11 plates. The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen, 2 plates.
„ XI.	„ 1857	The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright, 14 plates. The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen, 4 plates. The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen, 8 plates. The Polyzoa of the Crag, by Prof. Busk, 22 plates.
„ XII.	„ 1858	The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright, 7 plates. The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards, 6 plates. The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen, 7 plates. The Reptilia of the Purbeck Limestones, by Prof. Owen, 1 plate. The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous, by Mr. Davidson, 10 plates.
„ XIII.	„ 1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson, 20 plates. The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen, 6 plates. The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen, 1 plate. The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood, 13 plates.

* This Vol. is marked on the outside 1855.
† This Vol. is marked on the outside 1856.

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Vol. XIV.	Issued for the Year 1860	The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson, 8 plates. The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen, 11 plates. The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen, 1 plate. The Fossil Estheriæ, by Prof. Rupert Jones, 5 plates. The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell, 11 plates.
„ XV.	„ 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright, 13 plates. Supplement to the Great Oolite Mollusca, by Dr. Lycett, 15 plates.
„ XVI.	„ 1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright, 11 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter, 6 plates. The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson, 9 plates. The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood, 7 plates. The Reptilia of the Cretaceous and Wealden Formations (Supplements), by Prof. Owen, 10 plates.
„ XVII.	„ 1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter, 8 plates. The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson, 11 plates. The Belemnitidæ, Part I, Introduction, by Prof. Phillips. The Reptilia of the Liassic Formations, Part I, by Prof. Owen, 16 plates.
„ XVIII.	„ 1864	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright, 6 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter, 11 plates. The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips, 7 plates. The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford, 5 plates. Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
„ XIX.*	„ 1865	The Crag Foraminifera, Part 1, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, 4 plates. Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan, 10 plates. The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward, 9 plates. The Fossil Brachiopoda, Vol. III, Part VII, No. 1, Silurian, by Mr. Davidson, 12 plates.
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* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

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„ XXIX.*	„ 1875	The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright, 10 plates. The Fossil Trigoniæ, No. III, by Dr. Lycett, 8 plates. The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen, 20 plates.
„ XXX.*	„ 1876	The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady, 12 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson, 8 plates. Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen, 6 plates.
„ XXXI.*	„ 1877	Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates. The Fossil Trigoniæ, No. IV, by Dr. Lycett, 13 plates. The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood, 1 plate. The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair, 7 plates. The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen, 2 plates. The Fossil Elephants (E. antiquus), Part I, by Prof. Leith Adams, 5 plates.
„ XXXII.*	„ 1878	The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright, 8 plates. Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright. The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson, 13 plates. The Lias Ammonites, Part I, by Dr. Wright, 8 plates. The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall, 6 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen, 6 plates. The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

CATALOGUE OF WORKS—Continued.

Vol. XXXIII.*	Issued for the Year 1879	The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen, 5 plates. Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood, 6 plates. The Fossil Trigoniæ, No. V (*Conclusion*), by Dr. Lycett, 1 plate. The Lias Ammonites, Part II, by Dr. Wright, 10 plates. Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen, 4 plates. The Fossil Elephants (E. primigenius), Part II, by Prof. Leith Adams, 10 plates.
,, XXXIV.*	,, 1880	The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen, 6 plates. The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright, 3 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson, 8 plates. The Lias Ammonites, Part III, by Dr. Wright, 22 plates. The Reptilia of the London Clay, Vol. II, Part I (Chelone) by Prof. Owen, 2 plates.
,, XXXV.*	,, 1881	The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright, 6 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson, 5 plates. The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett. The Lias Ammonites, Part IV, by Dr. Wright, 10 plates. The Reptilia of the Liassic Formations, Part III (*Conclusion*), by Prof. Owen, 13 plates. The Fossil Elephants (E. primigenius and E. meridionalis), Part III (*Conclusion*), by Prof. Leith Adams, 13 plates.
,, XXXVI.*	,, 1882	The Eocene Flora, Vol. I, Part III (*Conclusion*), by Mr. J. S. Gardner and Baron Ettingshausen, 2 plates. Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood, 1 plate. The Fossil Echinodermata, Cret., Vol. I, Part X (*Conclusion*), by Dr. Wright, 5 plates. Supplement to the Fossil Brachiopoda, Vol. IV, Part V (*Conclusion*), by Dr. Davidson. Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson, 7 plates. The Lias Ammonites, Part V, by Dr. Wright, 22 plates.
,, XXXVII.*	,, 1883	The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner, 9 plates. The Trilobites of the Silurian, Devonian, &c., Formations, Part V (*Conclusion*), by the late Mr. J. W. Salter. The Carboniferous Trilobites, Part I, by Dr. H. Woodward, 6 plates. Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson, 10 plates. The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett, 4 plates. The Lias Ammonites, Part VI, by Dr. Wright, 8 plates.
,, XXXVIII.*	,, 1884	The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner, 11 plates. The Carboniferous Entomostraca, Part I, No. 2 (*Conclusion*), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady, 2 plates. The Carboniferous Trilobites, Part II, by Dr. H. Woodward, 4 plates. Supplement to the Fossil Brachiopoda, Vol. V, Part III (*Conclusion*), by Dr. Davidson, 4 plates. The Lias Ammonites, Part VII, by Dr. Wright, 10 plates.
,, XXXIX.*	,, 1885	The Eocene Flora, Vol. II, Part III (*Conclusion*), by Mr. J. S. Gardner, 7 plates. The Stromatoporoids, Part I, by Prof. Alleyne Nicholson, 11 plates. The Fossil Brachiopoda (Bibliography), Vol. VI (*Conclusion*), by the late Dr. Davidson and Mr. W. H. Dalton. The Lias Ammonites, Part VIII (*Conclusion*), by the late Dr. Wright, 1 plate.
,, XL.*	,, 1886	The Morphology and Histology of Stigmaria Ficoides, by Prof. W. C. Williamson, 15 plates. The Fossil Sponges, Part I, by Dr. G. J. Hinde, 8 plates. The Jurassic Gasteropoda, Part I, No. 1, by Mr. W. H. Hudleston. The Inferior Oolite Ammonites, Part I, by Mr. S. S. Buckman, 6 plates. The Pleistocene Mammalia, Part VI, by Prof. Boyd Dawkins, 7 plates.
,, XLI.*	,, 1887	The Fossil Sponges, Part II, by Dr. G. J. Hinde, 1 plate. The Palæozoic Phyllopoda, Part I, by Prof. T. R. Jones and Dr. Woodward, 12 plates. The Jurassic Gasteropoda, Part I, No. 2, by Mr. W. H. Hudleston, 6 plates. The Inferior Oolite Ammonites, Part II, by Mr. S. S. Buckman, 8 plates.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope.

CATALOGUE OF WORKS—Continued.

Vol. XLII.*	Issued for the Year 1888	The Stromatoporoids, Part II, by Prof. Alleyne Nicholson, 8 plates. The Tertiary Entomostraca (Supplement), by Prof. T. Rupert Jones and Mr. C. D. Sherborn, 3 plates. The Jurassic Gasteropoda, Part I, No. 3, by Mr. W. H. Hudleston, 5 plates. The Inferior Oolite Ammonites, Part III, by Mr. S. S. Buckman, 10 plates. The Devonian Fauna of the South of England, Part I, by the Rev. G. F. Whidborne, 4 plates. Title-pages to the Monographs on the Reptilia of the Wealden and Purbeck (Supplements), Kimmeridge Clay, and Mesozoic Formations, and on the Cetacea of the Red Crag.
„ XLIII.*	„ 1889	The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde, 4 plates. The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston, 5 plates. The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman, 13 plates. The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne, 12 plates.
„ XLIV.*	„ 1890	The Stromatoporoids, Part III, by Prof. Alleyne Nicholson, 6 plates. The Fossil Echinodermata, Cretaceous, Vol. II, Part I (Asteroidea), by Mr. W. Percy Sladen, 8 plates. The Inferior Oolite Ammonites, Part V, by Mr. S. S. Buckman, 8 plates. The Devonian Fauna of the South of England, Part III, by the Rev. G. F. Whidborne, 9 plates. Title-pages to the Supplement to the Fossil Corals, by Prof. Duncan.
„ XLV.*	„ 1891	The Jurassic Gasteropoda, Part I, No. 5, by Mr. W. H. Hudleston, 4 plates. The Inferior Oolite Ammonites, Part VI, by Mr. S. S. Buckman, 12 plates. The Devonian Fauna of the South of England, Part IV (*Conclusion of* Vol. I), 7 plates. „ „ Vol. II, Part I, by the Rev. G. F. Whidborne, 5 plates.
„ XLVI.*	„ 1892	The Stromatoporoids, Part IV (*Conclusion*), by Prof. Alleyne Nicholson, 4 plates. The Palæozoic Phyllopoda, Part II, by Prof. T. R. Jones and Dr. Woodward, 5 plates. The Jurassic Gasteropoda, Part I, No. 6, by Mr. W. H. Hudleston, 6 plates. The Inferior Oolite Ammonites, Part VII, by Mr. S. S. Buckman, 20 plates. The Devonian Fauna of the South of England, Vol. II, Part II, by the Rev. G. F. Whidborne, 5 plates.
„ XLVII.*	„ 1893	The Fossil Sponges, Part III, by Dr. G. J. Hinde, 10 plates. The Fossil Echinodermata, Cretaceous, Vol. II, Part II (Asteroidea), by Mr. W. Percy Sladen, 8 plates. The Inferior Oolite Ammonites, Part VIII, by Mr. S. S. Buckman, 16 plates. The Devonian Fauna of the South of England, Vol. II, Part III, by the Rev. G. F. Whidborne, 7 plates.
„ XLVIII.*	„ 1894	The Jurassic Gasteropoda, Part I, No. 7, by Mr. W. H. Hudleston, 6 plates. Carbonicola, Anthracomya, and Naiadites, Part I, by Dr. W. Hind, 11 plates. The Inferior Oolite Ammonites, Part IX, by Mr. S. S. Buckman, 11 plates. The Fishes of the Old Red Sandstone, Part II, No. 1, by Dr. R. H. Traquair, 4 plates.

* These Volumes are issued in two forms of binding; first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope.

§ II. LIST OF MONOGRAPHS

Completed, in course of Publication, and in Preparation.

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1. MONOGRAPHS which have been COMPLETED, and which may be bound as separate Volumes, with directions for the BINDING :—

The Morphology and Histology of Stigmaria ficoides by Prof. W. C. Williamson. (*Complete with Title-page and Index in the Volume for the year* 1886.)

The Eocene Flora, Vol. I (Filices), by Mr. J. S. Gardner and Baron Ettingshausen. (*Complete in the Volumes for the years* 1879, 1880, *and* 1882. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1882.)

The Eocene Flora, Vol. II (Gymnospermæ), by Mr. J. S. Gardner. (*Complete in the Volumes for the years* 1883, 1884, *and* 1885. *Title-page, Index, and directions for the binding, will be found in the Volume for* 1885.)

The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady. (*Complete in the Volume for the year* 1876.)

The Stromatoporoids, by Prof. Alleyne Nicholson. (*Complete in the Volumes for the years* 1885, 1888, 1890, and 1892. *The Title-page Index, and directions for binding will be found in the Volume for the year* 1892.)

The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime. (*Complete in the Volumes for the years* 1849, 1851, 1852, 1853, *and* 1854. *The Title-page and Index, with corrected explanations of Plates XVII and XVIII, will be found in the Volume for the year* 1854.)

Supplement to the Tertiary, Cretaceous, Liassic, and Oolitic Corals, by Prof. Martin Duncan. (*Complete in the Volumes for the years* 1865, 1866, 1867, 1868, 1869, 1872, *and* 1890. *The Title-page, with directions for binding, will be found in the Volume for the year* 1890.)

The Polyzoa of the Crag, by Mr. G. Busk. (*Complete with Title-page and Index in the Volume for the year* 1857.)

The Tertiary Echinodermata, by Professor Forbes. (*Complete with Title-page in the Volume for the year* 1852.)

The Fossil Cirripedes, by Mr. C. Darwin. (*Complete in the Volumes for the years* 1851, 1854, *and* 1858. *The Title-page will be found in the Volume for the year* 1854, *and the Index in the Volume for the year* 1858.

The Post-Tertiary Entomostraca, by Mr. G. S. Brady, the Rev. H. W. Crosskey, and Mr. D. Robertson. (*Complete, with Title-page and Index, in the Volume for the year* 1874.)

The Tertiary Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1855.)

The Cretaceous Entomostraca, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1849.)

Supplement to the Cretaceous Entomostraca, by Prof. T. Rupert Jones and Dr. G. J. Hinde. (*Complete, with Title-page and Index, in the Volume for the year* 1889.)

The Carboniferous Entomostraca, Part I (Cypridinadæ and their allies), by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady. (*Complete in the volumes for the years* 1874 *and* 1884. *The Title-page and Index will be found in the Volume for the year* 1884.)

The Fossil Estheriæ, by Prof. T. Rupert Jones. (*Complete, with Title-page and Index, in the Volume for the year* 1860.)

The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter. (*Complete in the Volumes for the years* 1862, 1863, 1864, 1866, *and* 1883. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Fossil Merostomata, by Dr. H. Woodward. (*Complete in the Volumes for the years* 1865, 1868, 1871, 1872, *and* 1878. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1878.)

The Fossil Brachiopoda (Tertiary, Cretaceous, Oolitic, and Liassic), Vol. I, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1850, 1852, 1853, *and* 1854. *The Index will be found in the Volume for the year* 1854, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Permian and Carboniferous), Vol. II, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1856, 1857, 1858, 1859, *and* 1860. *The Index will be found in the Volume for the year* 1860, *and corrected Title-page in that for* 1870.)

The Fossil Brachiopoda (Devonian and Silurian), Vol. III, by Mr. T. Davidson. (*Complete in the Volumes for the years* 1862, 1863, 1865, 1866, 1868, *and* 1870. *The Title-page and Index will be found in the Volume for the year* 1870.)

The Fossil Brachiopoda, Vol. IV, by Dr. T. Davidson. Supplements: Tertiary, Cretaceous, Jurassic, Triassic, Permian, and Carboniferous. (*Complete in the Volumes for the years* 1873, 1876, 1878, 1880, 1881, *and* 1882. *The Title-page and Index, with directions for the binding will be found in the Volume for the year* 1882.)

The Fossil Brachiopoda, Vol. V, by Dr. T. Davidson. Supplements : Devonian and Silurian. Appendix to Supplements, General Summary, Catalogue and Index of the British Species. (*Complete in the Volumes for the years* 1882, 1883, *and* 1884. *The Title-page, with directions for the binding will be found in the Volume for the year* 1884.)

The Fossil Brachiopoda, Vol. VI, by Dr. T. Davidson and Mr. W. H. Dalton. Bibliography. (*Complete in the Volume for the year* 1885.)

The Eocene Bivalves, Vol. I, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volumes for the years* 1859, 1862, *and* 1870. *The directions for the binding will be found in the Volume for the year* 1870.)

Supplement to the Eocene Bivalves, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1877.)

The Eocene Cephalopoda and Univalves, Vol. I, by Mr. F. E. Edwards and Mr. S. V. Wood. (*Complete in the Volumes for the years* 1848, 1852, 1854, 1855, 1858, *and* 1877. *The Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1877.)

The Mollusca of the Crag, Vol. I, Univalves, by Mr. S. V. Wood. (*The Text, Plates, and Index, will be found in the Volume for the year* 1847, *and the Title-page will be found in the Volume for the year* 1855.)

The Mollusca of the Crag, Vol. II, Bivalves, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1850, 1853, 1855, 1858, *and* 1873. *The Title-page will be found in the Volume for the year* 1873, *and the Index will be found in the Volume for the year* 1855, *and a Note in the Volume for the year* 1858).

The Mollusca of the Crag, Vol. III, Supplement, by Mr. S. V. Wood. (*Complete in the Volumes for the years* 1871 *and* 1873. *The Title-page and Index will be found in the Volume for the year* 1873.)

Second Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1879.)

Third Supplement to the Crag Mollusca, by Mr. S. V. Wood. (*Complete, with Title-page and Index, in the Volume for the year* 1882.)

The Great Oolite Mollusca, by Professor Morris and Dr. Lycett. (*Complete in the Volumes for the years* 1850, 1853, *and* 1854. *The Title-page and Index will be found in the Volume for the year* 1854.)

The Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1872, 1874, 1875, 1877, *and* 1879. *The directions for the binding will be found in the Volume for the year* 1879.)

Supplement to the Fossil Trigoniæ, by Dr. Lycett. (*Complete in the Volumes for the years* 1881 *and* 1883. *The Title-page, Index, with directions for the binding, will be found in the Volume for the year* 1883.)

The Oolitic Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1855, 1856, 1857, 1858, *and* 1878. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1878.)

The Oolitic Echinodermata, Vol. II, Asteroidea, by Dr. Wright. (*Complete in the Volumes for the years* 1861, 1864, *and* 1880. *Title-page, Index, and directions for the binding, will be found in the Volume for the year* 1880).

The Cretaceous Echinodermata, Vol. I, Echinoidea, by Dr. Wright. (*Complete in the Volumes for the years* 1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, *and* 1882. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1882.)

The Cretaceous (Upper) Cephalopoda, by Mr. D. Sharpe. (*Complete in the Volumes for the years* 1853, 1854, *and* 1855, *but wants Title-page and Index.*)

The Lias Ammonites, by Dr. Wright. (*Complete in the Volumes for the years* 1878, 1879, 1880, 1881, 1882, 1883, 1884, *and* 1885. *The Title-page and Index, with directions for the binding, will be found in the Volume for the year* 1885.)

The Fossils of the Permian Formation, by Professor King. *Complete, with Title-page and Index, in the Volume for the year* 1849. *Corrected explanations of Plates XXVIII and XXVIII* will be found in the Volume for the year* 1854.)

The Reptilia of the London Clay (and of the Bracklesham and other Tertiary Beds), Vol. I, by Professors Owen and Bell. (*Complete in the Volumes for the years* 1848, 1849, 1856, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.) Part I of Vol. II, containing Chelone gigas (*to be found in the Volume for the year* 1880), can be added.

The Reptilia of the Cretaceous Formations, by Prof. Owen. (*Complete in the Volumes for the years* 1851, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-page, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations, by Professor Owen. (*Complete in the Volumes for the years* 1853, 1854, 1855, 1856, 1857, 1858, 1862, *and* 1864. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1864.)

The Reptilia of the Wealden and Purbeck Formations (Supplements 4—9), by Professor Owen. (*Complete in the Volumes for the years* 1871, 1873, 1876, 1878, 1879, *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Reptilia of the Kimmeridge Clay Formation, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1868, and 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Reptilia of the Liassic Formations, by Professor Owen. (*Complete in the Volumes for the years* 1859, 1860, 1863, 1869, *and* 1881. *Directions for the binding, Title-pages, and Index, will be found in the Volume for the year* 1881.)

The Reptilia of the Mesozoic Formations, by Professor Owen. (*Complete in the Volume for the years* 1873, 1875, 1877, *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Red Crag Cetacea, by Professor Owen. (*Complete in the Volumes for the years* 1869 *and* 1888. *Directions for the binding, Title-page, Preface, and Table of Contents, will be found in the Volume for the year* 1888.)

The Fossil Mammalia of the Mesozoic Formations, by Professor Owen. (*Complete, with Title-page and Table of Contents, in the Volume for the year* 1870.)

The Fossil Elephants, by Professor Leith Adams. (*Complete in the Volumes for the years* 1877, 1879, *and* 1881. *Directions for the binding, Title-page, and Index will be found in the Volume for the year* 1881.

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2. MONOGRAPHS in course of PUBLICATION :*—

The Fossil Sponges, by Dr. G. J. Hinde.
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady.†
The Jurassic Gasteropoda, by Mr. W. H. Hudleston.
Carbonica, Anthracomya, and Naiadites, by Dr. Wheelton Hind.
The Palæozoic Phyllopoda, by Prof. T. Rupert Jones and Dr. H. Woodward.
The Trilobites, by Dr. H. Woodward.
The Inferior Oolite Ammonites, by Mr. S. S. Buckman.
The Belemnites, by Professor Phillips.‡
The Sirenoid and Crossopterygian Ganoids, by Professor Miall.
The Fishes of the Carboniferous Formation, by Dr. R. H. Traquair.
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie and E. Ray Lankester, and Professor Traquair.
The Pleistocene Mammalia, by Messrs. Boyd Dawkins and W. A. Sanford.
The Fauna of the Devonian Formation of the South of England, by the Rev. G. F. Whidborne.

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3. MONOGRAPHS which are promised or are in course of PREPARATION :*—

The Fossil Cycadeæ, by Mr. W. Carruthers.
The Graptolites, by Prof. Lapworth.
The Carboniferous Entomostraca, Part II (Leperditiadæ), by Prof. T. Rupert Jones.
The Wealden, Purbeck, and Jurassic Entomostraca, by Prof. T. R. Jones.
The Purbeck Mollusca, by Mr. R. Etheridge.
The Rhætic Mollusca, by Mr. R. Etheridge.
The Cambrian Fossils, by Dr. H. Hicks.
The Silurian Fish Bed, by Dr. Harley.
The Fossils of the Budleigh Salterton Pebble Bed, by the Rev. G. F. Whidborne.

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* Members having specimens which might assist the authors in preparing their respective Monographs are requested to communicate in the first instance with the Honorary Secretary.

† Will be finished by Prof. T. Rupert Jones.

‡ Unfinished through the death of the Author, but will be continued by Mr. G. C. Crick.

§ III. Dates of the Issue of the Yearly Volumes of the Palæontographical Society.

Volume	I	for	1847	was	issued	to the	Members,	March, 1848.
„	II	„	1848	„		„	„	July, 1849.
„	III	„	1849	„		„	„	August, 1850.
„	IV	„	1850	„		„	„	June, 1851.
„	V	„	1851	„		„	„	June, 1851.
„	VI	„	1852	„		„	„	August, 1852.
„	VII	„	1853	„		„	„	December, 1853.
„	VIII	„	1854	„		„	„	May, 1855.
„	IX	„	1855	„		„	„	February, 1857.
„	X	„	1856	„		„	„	April, 1858.
„	XI	„	1857	„		„	„	November, 1859.
„	XII	„	1858	„		„	„	March, 1861.
„	XIII	„	1859	„		„	„	December, 1861.
„	XIV	„	1860	„		„	„	May, 1863.
„	XV	„	1861	„		„	„	May, 1863.
„	XVI	„	1862	„		„	„	August, 1864.
„	XVII	„	1863	„		„	„	June, 1865.
„	XVIII	„	1864	„		„	„	April, 1866.
„	XIX	„	1865	„		„	„	December, 1866.
„	XX	„	1866	„		„	„	June, 1867.
„	XXI	„	1867	„		„	„	June, 1868.
„	XXII	„	1868	„		„	„	February, 1869.
„	XXIII	„	1869	„		„	„	January, 1870.
„	XXIV	„	1870	„		„	„	January, 1871.
„	XXV	„	1871	„		„	„	June, 1872.
„	XXVI	„	1872	„		„	„	October, 1872.
„	XXVII	„	1873	„		„	„	February, 1874.
„	XXVIII	„	1874	„		„	„	July, 1874.
„	XXIX	„	1875	„		„	„	December, 1875.
„	XXX	„	1876	„		„	„	December, 1876.
„	XXXI	„	1877	„		„	„	February, 1877.
„	XXXII	„	1878	„		„	„	March, 1878.
„	XXXIII	„	1879	„		„	„	May, 1879.
„	XXXIV	„	1880	„		„	„	May, 1880.
„	XXXV	„	1881	„		„	„	May, 1881.
„	XXXVI	„	1882	„		„	„	June, 1882.
„	XXXVII	„	1883	„		„	„	October, 1883.
„	XXXVIII	„	1884	„		„	„	December, 1884.
„	XXXIX	„	1885	„		„	„	January, 1886.
„	XL	„	1886	„		„	„	March, 1887.
„	XLI	„	1887	„		„	„	January, 1888.
„	XLII	„	1888	„		„	„	March, 1889.
„	XLIII	„	1889	„		„	„	March, 1890.
„	XLIV	„	1890	„		„	„	April, 1891.
„	XLV	„	1891	„		„	„	February, 1892.
„	XLVI	„	1892	„		„	„	November, 1892.
„	XLVII	„	1893	„		„	„	December, 1893.
„	XLVIII	„	1894	„		„	„	November, 1894.

§ IV. Summary of the Monographs issued to the Members (*up to* NOVEMBER, 1894): *showing in the* FIRST *column whether each Monograph hitherto published be* complete, *or in the* course of completion; *in the* SECOND *column, the yearly volumes which contain each particular Monograph* (*as a guide to binding the same*); *and in the* FOURTH *and following columns, the number of pages, plates, figures, and species described in the different Monographs.*

I. SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
The Morphology and Histology of Stigmaria ficoides, by Prof. W. C. Williamson, COMPLETE	1886	1887	66	15	91	1
The Eocene Flora, by Mr. J. S. Gardner and Baron Ettingshausen. Vol. I, COMPLETE	1879, 1880, 1882	1879, 1880, 1882	87	13	151	23
,, ,, by Mr. J. S. Gardner. Vol. II, COMPLETE	1883, 1884, 1885	1883, 1884, 1886	159	27	400	31
The Flora of the Carboniferous Strata, by Mr. E. W. Binney, *in course of completion*	1867, 1870, 1871, 1875	1868, 1871, 1872, 1875	147	24	141	16
The Fossil Sponges, by Dr. G. J. Hinde, *in course of completion*	1886, 1887, 1893	1887, 1888, 1893	254	19	602	106
The Crag Foraminifera, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady, *in course of completion*	1865	1866	78	4	211	43
The Carboniferous and Permian Foraminifera, by Mr. H. B. Brady, COMPLETE	1876	1876	166	12	266	62
The Stromatoporoids, by Prof. Alleyne Nicholson, COMPLETE	1885, 1888, 1890, 1892	1886, 1889, 1891, 1892	237	29	415	44
The Tertiary, Cretaceous, Oolitic, Devonian, and Silurian Corals, by MM. Milne-Edwards and J. Haime, COMPLETE (*k*)	1849, 1851, 1852, 1853, 1854	1850, 1851, 1852, 1853, 1855	406	72	800	319*g*
Supplement to the Tertiary, Cretaceous, Oolitic, and Liassic Corals, by Prof. Duncan, COMPLETE	1865, 1866, 1867, 1868, 1869, 1872, 1890	1866, 1867, 1868, 1869, 1870, 1872, 1891	232	49	797	149
The Polyzoa of the Crag, by Mr. G. Busk, COMPLETE	1857	1859	145	22	641	122
The Tertiary Echinodermata, by Prof. Forbes, COMPLETE	1852	1852	39	4	144	44
The Oolitic Echinodermata, by Dr. Wright. Vol. I, COMPLETE (*l*)	1855, 1856, 1857, 1858, 1878	1857, 1858, 1859, 1861, 1878	491	43	724	120*h*
,, ,, Vol. II, COMPLETE	1861, 1864, 1880	1863, 1866, 1880	207	22	232	35
The Cretaceous Echinodermata, by Dr. Wright. Vol. I, COMPLETE	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882	1864, 1868, 1870, 1871, 1872, 1874, 1875, 1878, 1881, 1882	390	87	1119	113
,, ,, by Mr. W. Percy Sladen. Vol. II, *in course of completion*	1890, 1893	1891, 1893	66	16	173	19
The Fossil Cirripedes, by Mr. C. Darwin, COMPLETE	1851, 1854, 1858*a*	1851, 1855, 1861	137	7	320	54
The Fossil Merostomata, by Dr. H. Woodward, COMPLETE	1865, 1868, 1871, 1872, 1878	1866, 1869, 1872, 1872, 1878	265	36	365	51
The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson, COMPLETE	1874	1874	237	16	515	134
The Tertiary Entomostraca, by Prof. Rupert Jones, COMPLETE	1855	1857	74	6	233	56
,, ,, ,, and Mr. C. D. Sherborn (Supplement), COMPLETE	1888	1889	55	3	134	48
The Cretaceous Entomostraca, by Prof. Rupert Jones, COMPLETE	1849	1850	41	7	176	31
,, ,, ,, and Dr. G. J. Hinde (Supplement)	1889	1890	78	4	258	46
The Carboniferous Entomostraca, by Prof. Rupert Jones and Messrs. J. W. Kirkby and Prof. G. S. Brady. Part I, COMPLETE	1874, 1884	1874, 1884	95	7	374	81
The Fossil Estheriæ, by Prof. Rupert Jones, COMPLETE	1860	1863	139	5	158	19*i*
		CARRIED FORWARD...	4291	549	9440	1767

SUMMARY OF THE MONOGRAPHS ISSUED TO THE MEMBERS (*up to* NOVEMBER, 1894)—*continued.*

SUBJECT OF MONOGRAPH.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		BROUGHT FORWARD...	4291	549	9440	1767
The Palæozoic Phyllopoda, by Prof. Rupert Jones and Dr. H. Woodward, *in course of completion*	1887, 1892	1888, 1892	124	17	226	72
The Trilobites of the Cambrian, Silurian, and Devonian Formations, by Mr. J. W. Salter, COMPLETE	1862, 1863, 1864, 1866, 1883	1864, 1865, 1866, 1867, 1883	224	31	703	114
The Carboniferous Trilobites, by Dr. H. Woodward, COMPLETE	1883, 1884	1883, 1884	86	10	148	31
The Malacostracous Crustacea (comprising those of the London Clay, Gault, and Greensands), by Prof. T. Bell, *in course of completion*	1856, 1860	1858, 1863	88	22	215	50
The Fossil Brachiopoda, Vol. I. The Tertiary, Cretaceous, Oolitic, and Liassic Brachiopoda, by Mr. T. Davidson, COMPLETE	1850, 1852, 1853, 1854	1851, 1852, 1853, 1855	409	42	1855	160
„ „ Vol. II. The Permian and Carboniferous Brachiopoda, COMPLETE	1856*d*, 1857, 1858, 1859, 1860	1858, 1859, 1861, 1861, 1863	331	59	1909	157
„ „ Vol. III. The Devonian and Silurian Brachiopoda, COMPLETE	1862, 1863, 1865, 1866, 1868, 1870	1864, 1865, 1866, 1867, 1869, 1871	528	70	2766	321
„ „ Vol. IV. Supplements, Tertiary to Carboniferous, COMPLETE	1873, 1876, 1878, 1880, 1881, 1882	1874, 1876, 1878, 1880, 1881, 1882	383	42	1664	215
„ „ Vol. V. Supplements, Devonian and Silurian, COMPLETE	1882, 1883, 1884	1882, 1883, 1884	476	21	1135	116
„ „ Vol. VI. Bibliography, COMPLETE	1885	1886	163	—	—	—
The Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1872, 1874, 1875, 1877, 1879	1872, 1874, 1875, 1877, 1879	246	41	446	115
Supplement to the Fossil Trigoniæ, by Dr. Lycett, COMPLETE	1881, 1883	1881, 1883	19	4	53	9*h*
The Mollusca of the Crag, by Mr. S. V. Wood. Vol. I. (Univalves), COMPLETE	1847, 1855*b*	1848, 1857	216	21	581	244
Vol. II. (Bivalves), COMPLETE	1850, 1853, 1855, 1858*c*	1851, 1853, 1857, 1861	344	31	691	253
Supplements to the Crag Mollusca, No. I, II, and III, by Mr. S. V. Wood, COMPLETE	1871, 1873, 1879, 1882	1872, 1874, 1879, 1882	346	19	546	245
The Eocene Mollusca, Cephalopoda and Univalves, by Mr. F. E. Edwards, continued by Mr. S. V. Wood. Vol. I, COMPLETE	1848, 1852, 1854, 1855, 1858, 1877	1849, 1852, 1855, 1857, 1861, 1877	361	34	625	275
The Eocene Mollusca, Bivalves, by Mr. S. V. Wood. Vol. I, COMPLETE	1859, 1862, 1870	1861, 1864, 1871	182	25	531	194
Supplement to the Eocene Mollusca, by Mr. S. V. Wood (Bivalves). Vol. I, COMPLETE	1877	1877	24	2	66	30
The Great Oolite Mollusca, by Prof. Morris and Dr. Lycett, COMPLETE	1850, 1853, 1854	1851, 1853, 1855	282	30	846	419
„ „ „ Supplement by Dr. Lycett, COMPLETE	1861	1863	129	15	337	194
The Jurassic Gasteropoda, by Mr. W. H. Hudleston, *in course of completion*	1886, 1887, 1888, 1889, 1891, 1892, 1894	1887, 1888, 1889, 1890, 1892, 1892, 1894	382	32	1015	333
Carbonicola, Anthracomya, and Naiadites, by Dr. Wheelton Hind, *in course of completion*	1894	1894	80	11	361	17
The Inferior Oolite Ammonites, by Mr. S. S. Buckman, *in course of completion*	1886, 1887, 1888, 1889, 1890, 1891, 1892, 1893, 1894	1887, 1888, 1889, 1890, 1891, 1892, 1892, 1893, 1894	456	104	1137	168
The Liassic Ammonites, by Dr. Wright, COMPLETE	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885	1878, 1879, 1880, 1881, 1882, 1883, 1884, 1886	503	91	726	107
		CARRIED FORWARD...	10673	1323	28022	5606

Summary of the Monographs issued to the Members (*up to* NOVEMBER, 1894)—*continued.*

I. Subject of Monograph.	II. Dates of the Years *for which* the volume containing the Monograph was issued.	III *m*. Dates of the Years *in which* the Monograph was published.	IV. No. of Pages of Letterpress in each Monograph.	V. No. of Plates in each Monograph.	VI. No. of Lithographed Figures and of Woodcuts.	VII. No. of Species described in the Text.
		Brought forward...	10673	1323	28022	5606
The Belemnites, by Prof. Phillips, *in course of completion*	1863, 1864, 1866, 1868, 1869	1865, 1866, 1867, 1869, 1870	128	36	622	69
The Upper Cretaceous Cephalopoda, by Mr. D. Sharpe, COMPLETE	1853, 1854, 1855	1853, 1855, 1857	67	27	319	79
The Fossils of the Permian Formation, by Prof. King, COMPLETE	1849, 1854*e*	1850, 1855	287	29	511	138
The Fauna of the Devonian Formation, by the Rev. G. F. Whidborne, Vol. I, COMPLETE	1888, 1889, 1890, 1891	1889, 1890, 1891, 1892	346	32	770	206
,, ,, ,, Vol. II, *in course of completion*	1891, 1892, 1893	1892, 1892, 1893	160	17	355	142
The Sirenoid Ganoids, by Prof. Miall, *in course of completion*	1878	1878	32	6	61	6
The Fishes of the Carboniferous Formation, by Dr. Traquair, *in course of completion*	1877	1877	60	7	58	5
The Fishes of the Old Red Sandstone, by Messrs. J. Powrie, E. Ray Lankester, and Dr. Traquair, *in course of completion*	1867, 1869, 1894	1868, 1870, 1894	90	18	232	22
The Reptilia of the London Clay [and of the Bracklesham and other Tertiary Beds], by Profs. Owen and Bell, Vol. I, COMPLETE ‡	1848, 1849, 1856*f*	1849, 1850, 1859	150	58	304	39
,, ,, Vol. II, Part I, by Prof. Owen, COMPLETE	1880	1880	4	2	4	1
The Reptilia of the Cretaceous Formations, by Prof. Owen, COMPLETE‡	1851, 1857, 1858, 1862	1851, 1859, 1861, 1864	184	59	519	26
The Reptilia of the Wealden and Purbeck Formations (with Supplements 1, 2, 3), by Prof. Owen, COMPLETE ‡	1853, 1854, 1855, 1856, 1857, 1858, 1862	1853, 1855, 1857, 1858, 1859, 1861, 1864	155	62	251	17
The Reptilia of the Wealden and Purbeck Formations (Supplements 4—9), COMPLETE	1871, 1873, 1876, 1878, 1879, 1888*n*	1872, 1874, 1876, 1878, 1879, 1889	85	21	175	15
The Reptilia of the Kimmeridge Clay Formation, by Prof. Owen, COMPLETE	1859, 1860, 1868, 1888*n*	1861, 1863, 1869, 1889	16	6	23	4
The Reptilia of the Liassic Formations, by Prof. Owen, COMPLETE	1859,‖ 1860,‖ 1863, 1869, 1881*n*	1861, 1863, 1865, 1870, 1881	174	50	276	20
The Reptilia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1873, 1875, 1877, 1888*n*	1874, 1875, 1877	101	24	165	17
The Red Crag Cetacea, by Prof. Owen, COMPLETE	1869, 1888*n*	1870, 1889	42	5	43	9
The Fossil Elephants, by Prof. Leith Adams, COMPLETE	1877, 1879, 1881*n*	1877, 1879, 1881	265	28	216	3
The Pleistocene Mammalia, by Messrs. W. Boyd Dawkins and W. A. Sanford, *in course of completion*	1864, 1867, 1868, 1871, 1878, 1886	1866, 1868, 1869, 1872, 1878, 1887	333	39	340	12
The Mammalia of the Mesozoic Formations, by Prof. Owen, COMPLETE	1870	1871	115	4	247	30
		Total	13467	1853	33513	6466

a Index. *b* Title-page to Univalves. *c* Note to Crag Mollusca. *d* Contains the Permian. *e* Two corrections of Plates. *f* Supplement.
g Many of the species are described, but not figured. *h* British species only reckoned. *i* British species only reckoned. *k* A Supplement is now in course of publication.
l Index will be found in 1878 vol. *m* Useful for establishing the dates of new species. *n* Contains title-pages and directions for binding.
‡ Title-pages and Index will be found in the 1864 Volume. ‖ Marked on outside label 'Reptilia of Oolitic Formations.'

§ V. Stratigraphical Table *exhibiting the* British Fossils *already figured and described in the* Annual Volumes (1847—1894) *of the* Palæontographical Society.

	PLANTS.	PROTOZOA.		RADIATA.		ARTICULATA.					
		Sponges.	Foraminifera.	Stromatoporoids and Corals.	Echinodermata.	Cirripedes.	Cypridæ, Cytherinæ, &c.	Phyllopoda.	Merostomata.	Trilobites.	Malacostracous Crustacea.
Pleistocene	...	...	...	...	......	......	1874, 1888				
Crag	...	...	1865	1849	1852	1851, 1854	1888				
Eocene	1879, 1880, 1882, 1883, 1884, 1885	...	...	1849, 1865	1852	1851, 1854	1855, 1888	...	......	......	1856
Cretaceous.........	...	...	...	1849, 1868, 1869	1862, 1867, 1869, 1870, 1872, 1873, 1875, 1878, 1881, 1882, 1890, 1893	1851, 1854	1849, 1889	...	......	......	1860
Wealden	...	...	...	...	......	......	...	1860			
Oolitic	...	1893	...	1851, 1872	1855, 1856, 1857, 1858, 1861, 1878, 1880	1851	...	1860			
Liassic	...	1893	...	1851, 1866, 1867	1855, 1856, 1858, 1861, 1864						
Triassic	...	...	...	...	1880	......	...	1860			
Permian	1849	1849	1849, 1876	1849, 1852	1849	......	1849	1860			
Carboniferous...	1867, 1870, 1871, 1875, 1886	1887	1876	1852	......	......	1874, 1884	1860, 1887	1872, 1878	1883, 1884	
Devonian	...	1887	...	1853, 1885, 1888, 1890, 1892	......	......	1888	1860	1865, 1868, 1872, 1878	1862, 1888	
Silurian.	...	1886, 1887	...	1854, 1885, 1890	......	......	...	1887, 1892	1868, 1871, 1872, 1878	1862, 1863, 1864, 1866	
Cambrian	...	1886, 1887	...	1890	.....	......	...	1887	......	1864	

Note.—The numbers in the above List refer to the Volumes issued for those Dates.

STRATIGRAPHICAL TABLE *exhibiting the* BRITISH FOSSILS *already figured and described in the* ANNUAL VOLUMES (1847—1894) *of the* PALÆONTOGRAPHICAL SOCIETY (*continued*).

	MOLLUSCA.				VERTEBRATA.		
	Polyzoa.	Brachiopoda.	Monomyaria, Dimyaria, and Gasteropoda.	Cephalopoda.	Fishes.	Reptiles.	Mammalia.
Pleistocene	...	1873	......	...	...	......	1864, 1867, 1868, 1871, 1877, 1878, 1879, 1881, 1886
Crag	1857	1852, 1873, 1879	1847, 1850, 1853, 1855, 1871, 1873, 1879, 1882	...	...	......	1869, 1881, 1888
Eocene	...	1852, 1873	1852, 1854, 1855, 1858, 1859, 1862, 1870, 1877	1848	...	1848, 1849, 1856, 1880	
Cretaceous.........	...	1852, 1854, 1873, 1884	1872, 1875, 1877, 1879	1853, 1854, 1855	...	1851, 1857, 1858, 1862, 1873, 1888	
Wealden	...	... ..	......	...	...	1853, 1854, 1855, 1856, 1857, 1862, 1871, 1873, 1875, 1876, 1878, 1879	
Oolitic	...	1850, 1852, 1876, 1878, 1884	1850, 1853, 1854, 1872, 1874, 1875, 1877, 1879, 1883, 1886, 1887, 1888, 1889, 1891, 1892, 1894	1850, 1861, 1868, 1869, 1886, 1887, 1888, 1889, 1890, 1891, 1892, 1894	...	(Purbeck) 1853, 1858 (Kim. Clay), 1859, 1860, 1868, 1873, 1875, 1877, 1888 (Great Oolite) 1875, 1888	1870
Liassic	...	1850, 1852, 1876, 1878, 1884	1874, 1877, 1879, 1883	1863, 1864, 1866, 1868, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885,	...	1859, 1860, 1863, 1869, 1873, 1881	
Triassic............	...	1876, 1878	1879	......	1878	......	1870
Permian	1849	1849, 1856, 1880	1849	1849	1849	1849	
Carboniferous ...	...	1856, 1857, 1858, 1859, 1860, 1880, 1884	1894	......	1877		
Devonian	...	1862, 1863, 1881, 1882, 1884, 1893	1890, 1891, 1892, 1893	1889	1867, 1869, 1894		
Silurian............	...	1865, 1866, 1868, 1870, 1881, 1882, 1883					
Cambrian							

NOTE.—The numbers in the above List refer to the Volumes issued for those Dates.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1894.

LONDON:
MDCCCXCIV.

A MONOGRAPH

OF THE

BRITISH JURASSIC GASTEROPODA.

BY

WILFRID H. HUDLESTON, M.A., F.R.S., F.L.S.

PART I, No. 7.

GASTEROPODA OF THE INFERIOR OOLITE.

Pages 325—390; Plates XXVII—XXXII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1894.

PRINTED BY ADLARD AND SON,
BARTHOLOMEW CLOSE, E.C., AND 20, HANOVER SQUARE, W.

Genus—Onustus, Humphrey, 1797.

We owe to the late Eugène Deslongchamps, in the first instance, the recognition of the fact that several trochiform shells found in the Jurassic rocks, which had been referred by d'Orbigny to the genus *Trochus*, might with more propriety be classed under the genus *Onustus*. Deslongchamps published his conclusions on this subject in 1860,[1] and pointed out that in the Jurassic rocks of France the genus had been noted in the Middle Lias, the Upper Lias, the Inferior Oolite, the Great Oolite, and the Callovian. Lycett in 1863[2] accepted these conclusions, and gave a diagnosis, based upon that of Deslongchamps, more especially applicable to the Jurassic species.

Shell conical, wide-angled, whorls flattened or rendered somewhat concave by an expansion of their lower borders, which overhang and conceal the suture; the lower border of the last whorl is produced horizontally; surface irregularly striated.

The base is concave towards the outer border and convex towards the centre; the umbilical orifice is sometimes large but in other instances small, and becomes nearly concealed by advance of growth; the aperture is depressed and oblique, columellar side curved, outer lip angular and produced.—Modified after Lycett.

As observed by Lycett, none of the Jurassic species exhibit those agglutinations of shells and stones which are so characteristic of the Tertiary and Recent examples of *Onustus.*

In the Jurassic rocks of this country the genus is first noted in the Upper Lias, where fairly characteristic specimens of *O. heliacus*, d'Orb., are quoted from more than one locality, and a similar form occurs in the Lias-Oolite sands of Nibley, in Gloucestershire.

A small and interesting form, near to *O. heliacus,* occurs sparingly in the *Opalinus*-zone; whilst the *Murchisonæ*-zone is characterised by a group of much larger forms, which it is convenient to focus for the most part under *Onustus pyramidatus*, Phil. In the Upper Division of the Inferior Oolite *Onustus ornatissimus*, d'Orb., is far from uncommon at Burton Bradstock, and a variety of this has been noted by Morris from the Lincolnshire Limestone. The genus is but poorly represented in the Inferior Oolite of the Cotteswolds, and has not been recorded, to my knowledge, from the Great Oolite of Minchinhampton. The French authors have described one or two species from the Bathonian and Callovian of France, and Lycett described *Onustus Burtonensis* from the Forest-Marble of Burton Bradstock.

[1] 'Bull. Soc. Linn. Norm.,' vol. v.

[2] 'Suppl. to Great Oolite Mollusca,' p. 103.

There can be little doubt that these shells have their ornamentation considerably modified by the accidents of preservation and mineralisation, so that appearances are not altogether to be trusted. This is especially the case in the Dogger, where it sometimes happens that the characteristic species, *O. pyramidatus*, Phil., appears deprived of all its costæ, or is otherwise so modified as to invite distinct recognition. Hence my hesitation to deal with forms which undoubtedly present considerable variety, and which under other conditions I should scarcely hesitate to regard as fairly distinct species. Roughly speaking, the Jurassic species referred to *Onustus* may be divided into two groups, viz. (1) that represented by *O. pyramidatus*, Phil., where the basal periphery is almost simple and the base nearly smooth. To this group belong *O. lamellosus*, d'Orb., and *O. acuminatus*, sp. n. (Pl. XXVII, fig. 3), in the Inferior Oolite; *O. liasinus*, E. Desl., of the Middle Lias of May; and *O. papyraceus*, Héb. and Desl., from the Callovian of Montreuil-Bellay. (2) The second group is represented by *O. ornatissimus*, d'Orb., where the basal periphery is more or less serrated, whilst in the majority of cases the base itself is more or less marked by spiral striæ. This group includes *O. heliacus*, d'Orb., of the Upper Lias, and the var. *opalina* (Pl. XXVII, fig. 4). In *O. Heberti*, Laube, the characters of the two groups seem to be somewhat blended.

259. ONUSTUS PYRAMIDATUS, *Phillips*, 1829. Plate XXVII, figs. 1 and 2.

1829, 1835. TROCHUS PYRAMIDATUS, *Phillips*. Geol. Yorks., pt. 1, pl. xi, fig. 22.
1884. ONUSTUS PYRAMIDATUS, *Phil.*, sp. Hudleston, Geol. Mag., dec. 3, vol. i, p. 294, pl. ix, figs. 2 and 3.

See also for this group of *Onustus*—

TROCHUS LAMELLOSUS, *d'Orbigny*. Terr. Jur., vol. ii, p. 270, pl. cccxi, figs. 11—13.
ONUSTUS LIASINUS, *Eugène Deslongchamps*. Bull. Soc. Linn. Norm., vol. v, pl. x, fig. 10.
— PAPYRACEUS, *Héb. and Desl.* Op. et vol. cit., pl. ix, fig. 3.
— ORNATISSIMUS, *Hudl.*, non *d'Orb.* Geol. Mag., dec. 3, vol. i, p. 293, pl. ix, fig. 1.

Bibliography, &c.—The original *Trochus pyramidatus*, now preserved in the York Museum, does not very much resemble the figure by Phillips in the 'Geology of Yorkshire,' which seems to represent a more costated shell. I think, however, the specimen may have suffered from scaling, to which fossils from the Dogger are liable.

Description.—The following are the proportions of the type specimen:

Height	17 mm.
Width	23 mm.
Spiral angle	80°.

The spiral angle may be said to range from about 80° to 86°, and is slightly concave to nearly regular. Whorls six to seven in number; they are irregularly concave and more or less overlap, the line of junction being usually slightly crenulated. The costæ are numerous, prominent, straight or slightly sinuous, the intercostal spaces being roughened by closely-set lamellæ, which give a scaly appearance. This is much more conspicuous in some specimens than in others—a circumstance which may be attributed to differences in mineralisation.

The margin of the base is but slightly crenulated, the peripheral edge being almost plain, and so thin that the outline is seldom perfectly preserved in any of the specimens. The base has very fine radial lines, with occasional traces of spiral ones, but is otherwise smooth; it is only slightly concave, rising again towards the columella. There is a semicircular umbilical excavation of moderate dimensions, but no umbilicus. Aperture very oblique.

Varieties.—Of those to which it may be necessary to draw particular attention the most frequent is one which occurs in the Dogger and elsewhere, and which was mistaken by me for *O. ornatissimus*, d'Orb. (*vide* 'Geol. Mag.' *ut supra*). In this form the costæ are very short, and do not meet, so that the imbrication or overlap of the whorls is very conspicuous; spire conical. This variety might be known as *semicostata*.

Another variety from the Dogger is a very conical form, presenting the usual characteristics of *O. pyramidatus*, especially the flat and scarcely excavated base, but is absolutely devoid of costæ. Whether or no this is a trick of mineralisation seems uncertain. This may be known as var. *incostata*.

There are also in the *Murchisonæ*-zone of Bradford Abbas and Halfway House some megalomorphs, which it would seem proper to regard as referable to this species, the more so as they exhibit the characteristic base; one of these must have measured 40 mm. in width. These seem to answer to Eugène Deslongchamps' description of *Onustus lamellosus*, d'Orb. (*vide* 'Bull. Soc. Linn. Norm.,' vol. v, p. 133).

Relations and Distribution.—*Onustus pyramidatus* may be regarded as the most abundant representative of the genus in the Jurassic rocks; distinguished from *O. heliacus*, d'Orb., by its larger habit, more closely-set costæ, and more scaly surface, and also by the greater smoothness of the basal border. The same features will also serve to distinguish it from *O. ornatissimus*, d'Orb.

It is not common anywhere, but occurs mostly in the Yorkshire Dogger

and in the lower zones of the Inferior Oolite in Dorset, especially at Bradford Abbas. Rare at Duston.

The two species next described are closely related, and indeed *Onustus acuminatus* is little more than a variety.

260. ONUSTUS ACUMINATUS, sp. nov. Plate XXVII, fig. 3.

Description:

Height restored	22 mm.
Width	26 mm.
Opening of spiral angle . . .	40°.
Mean spiral angle	75°.

Shell pyramidal, imperforate; spiral angle extremely concave. Number of whorls about nine; the apical whorls are flat, but with the increase of the spiral angle become much more excavated, so much so that the spire seems as if it scarcely belonged to the three anterior whorls. The ornaments are similar to those in some of the varieties of *O. pyramidatus*, the costæ being fully developed to the very edge of each whorl. The base is flat, smooth, or with slight radial lines of growth, and there is scarcely any trace of an umbilical excavation.

Relations and Distribution.—This form exhibits the concave spiral angle to a far greater extent than any species of *Onustus* in the Inferior Oolite of this country, in this respect somewhat resembling *Onustus papyraceus*, Héb. and Desl., from the Callovian of Montreuil-Bellay. It is quite possible that where the spire has been lost there are no means of distinguishing *O. acuminatus* from the more common *O. pyramidatus*.

Rare in the *Murchisonæ*-zone at Bradford Abbas, and probably occurring on the same horizon at one or two other places in North Dorset. There are two specimens from the Inferior Oolite of Nailsworth, now in the Jermyn Street Museum, which may be referred to *O. acuminatus*.

261. ONUSTUS, species or variety. Plate XXVII, figs. 5 *a*, 5 *b*.

Description:

Height	16 mm.
Width	23 mm.
Spiral angle	82°.

The proportions in this form are very similar to those of an average specimen of *O. pyramidatus.* The chief differences to note are that the costæ are finer and more numerous, the scaly character remaining much about the same. Instead, however, of the nearly flat and unexcavated base, there is a very marked umbilical cavity. The base is plain, convex towards the centre, and presents towards the periphery a wide channel occasioned by the overlap of the margin of the body-whorl. It is true that this feature is partly shared by all varieties of the *pyramidatus*-group, but it seems especially developed in this form.

Relations and Distribution.—In many respects this variety approaches *O. lamellosus*, d'Orb., more especially in the character of the base. None of our specimens exhibit the fine spiral striæ round the umbilicus mentioned by the author, but the absence of these might easily be accounted for by the state of preservation.

Very rare at Bradford Abbas; the figured specimen is from the *Concavus*-bed.

262. ONUSTUS HELIACUS, d'Orbigny, var. OPALINA. Plate XXVII, figs. 4 *a*, 4 *b*.

In this variety, which is rather narrower than the typical form, the spiral angle rarely attains to 70°. The figure is perfectly conical, rather reminding us of *O. pyramidatus*, from which species it obviously differs in its smaller habit of growth, in the wideness of the space between the axial costæ, and in the more crenulated margin of the base.

The base itself is smooth with fine radial lines. In the figured specimen very slight spiral striæ are also noted. There is scarcely even a trace of an umbilical fissure, and this seems inconsistent with d'Orbigny's description of *O. heliacus*. But Eugène Deslongchamps tells us ('Bull. Soc. Linn. Norm.,' vol. v, p. 132) that the so-called umbilicus in that species is a mere umbilical hollow.

This variety of *O. heliacus* occurs on or about the *Opalinus*-zone at Drympton and Burton Bradstock. The majority of the specimens are in very bad condition, but the width between the costæ in those cases where the crenulated margin is broken away will serve to distinguish it from all varieties of the *pyramidatus*-group.

263. ONUSTUS HEBERTI, *Laube*, 1867. Plate XXVII, figs. 6 *a*, 6 *b*, and 7.

1867. ONUSTUS HEBERTI, *Laube*. Gastropoden des braunen Jura von Balin, p. 14 (sep. copy), pl. iii, fig. 5.

Bibliography, &c.—The author recognised a form of *Onustus*, occurring rarely at Balin and Sanka, which he regarded as occupying an intermediate position between *O. ornatissimus*, d'Orbigny, and *O. papyraceus*, Héb. and Desl., the latter representing the section of which *O. pyramidatus* is the type.

Description:

Height	10 mm.
Width	12 mm.
Spiral angle	68°.

Shell short, conical, pointed. The spiral angle but slightly concave. Number of whorls about six. These are flat, closely fitting, and ornamented with very regular costæ of moderate prominence, so arranged that there are about thirty in the body-whorl. The intercostal spaces are moderately scaly.

Base nearly flat, but rising towards the rhomboidal aperture; peripheral border slightly crenulated. There is a very faint submarginal channel, and an umbilical hollow rather than a true umbilicus: spiral striæ of the base very distinct.

Relations and Distribution.—Although this shell does not correspond in all respects with the form described by Laube, its obviously intermediate character between the *pyramidatus*-group and *O. ornatissimus* must be my justification for thus identifying it. Whilst the flanks of the shell are characteristic of *O. pyramidatus* and its allies, though with a narrower spiral angle, the spiral ornamentation of the base entirely removes it from this group, and brings it into comparison with the still stronger basal striæ of the species next described.

A single specimen from Stoford, horizon unknown. Fig. 7, representing a shell from the *Cadomensis*-bed, Oborne, may be a variety.

264. Onustus ornatissimus, *d'Orbigny*, 1850. Plate XXVII, figs. 8 *a*, 8 *b*.

1850.	Trochus ornatissimus, *d'Orbigny*.	Prod., i, p. 264.
1852.	— — —	Terr. Jur., vol. ii, p. 272, pl. cccxii, figs. 5—8.
Cf. also	— — —	?, var. Pontonis. *Morris*, Quart. Journ. Geol. Soc., vol. ix, p. 343, pl. xiv, fig. 10.
Non	Onustus ornatissimus, *d'Orb.*, sp.	Hudleston, Geol. Mag., dec. 3, vol. i, p. 293, pl. ix, fig. 1.

Description:

Height of average specimen . . .	10—12 mm.
Width	17—19 mm.
Spiral angle (concave)	80°—85°.

The following description by d'Orbigny suits the British specimens very well. "Shell much wider than high, considerably umbilicated. Spire formed by a concave angle, excavated, composed of whorls somewhat concave, furnished axially with straight costæ, radiating from the summit of the spire towards the margin, where they are terminated by a point. In the interspaces are fine oblique transverse lamellæ. The last whorl, somewhat convex above, carinated, and with points on the periphery, is umbilicated in the centre, and around this occurs a prominence with concentric striæ." The aperture is rhomboidal and depressed, as in all species of *Onustus* from the Jurassic rocks.

Relations and Distribution.—This species is easily distinguished from *O. pyramidatus* and its allies by the coarseness and wideness apart of the axial costæ and the serrated character of the basal periphery, which in some specimens almost equals the figures in the 'Terrains Jurassiques.' Fig. 8 of the accompanying plate represents the usual British form, whilst fig. 7 represents a peculiar form occurring in the upper part of the *Humphriesianus*-zone at Oborne, which seems to connect rather with *O. Heberti.*

In the width between the costæ and in some other respects *O. ornatissimus* presents certain analogies with *O. heliacus* and its varieties, which it also more resembles in size; but it is distinguished from that species by the presence of a distinct umbilicus, the edge of which is spirally striated, and also by the much stronger serrations of the basal periphery. Typical specimens are somewhat abundant in the *Parkinsoni*-zone of Burton Bradstock and Vitney Cross, but very rare elsewhere, and almost unknown much further north.

Var. *Pontonis,* Morris.—Specimens from the Lincolnshire Limestone are in such a poor state of preservation that it is difficult to say what their relations may be. I have a specimen from Ponton which seems to be a small variety of this species, but as the base is not seen the identification cannot be regarded as certain.

Family—NERITIDÆ.

Shell imperforate, globular, semiglobular, or patelliform; spire very small, cavity simple owing to the absorption of the internal portions of the whorls; aperture semilunate; columellar side expanded and often flattened.

In the Inferior Oolite of this country the following genera or sub-genera occur, viz. *Nerita*, *Neridomus*, and *Pileolus*. Of these *Neridomus* is perhaps best considered as a section of *Nerita* allied to *Neritina*. Shells of this family are far from abundant in our Inferior Oolite. They mostly occur on a low horizon, and appear to be wanting in the rich shell-beds of the Dorset-Somerset district.

Genus—Nerita, *Linnæus*, 1758.

Systematic conchologists, such as Fischer, do not carry the genus *Nerita* so far back in time as the Jurassic period. That author ('Manuel,' p. 800) observes that the Jurassic forms of *Nerita* are doubtful and belong to the genus *Neridomus*, Morris and Lycett. Accepting provisionally the classification of these authors for the Neritoid shells of the Lower Oolites, I think that *Nerita* will cover the more rugose and costated forms with flattened inner lip, though, as far as my experience goes, there is no denticulation of the edge. Viewing *Neridomus* as a section of *Nerita*, this will include shells which are smooth and have the inner lip convex. It has always seemed to me that *Neridomus* was more nearly related to *Neritina* than to *Nerita*. Cossmann, I may remark, is disposed to query the value of the generic distinction between *Neritina* and *Nerita*, and he has no hesitation in placing all the Nerite-like shells of the Jurassic rocks under *Nerita*.[1]

As a matter of fact, I distinguish in our Inferior Oolite three rugose and costated forms, which no doubt are closely related, and more or less run into each other. There are also two, if not three, fairly distinct smooth forms which belong to the section *Neridomus*, besides some others which are too obscure to notice.

265. Nerita costulata, *Deshayes*, 1838. Plate XL, figs. 6 *a*, 6 *b*; and ? Plate XXVIII, figs. 6 *a*, 6 *b*.

1824. Nerita costata, *Sowerby*. Min. Conch., pl. cccclxiii, figs. 5 and 6.
1838. — costulata, *Deshayes*. Lamarck, Anim. sans Vert., 2nd edit., vol. viii, p. 617.
1851. — — — Morris and Lycett, Great Ool. Moll., pt. i, p. 57, pl. viii, fig. 6.
1884. ? — — — [var.] *Hudleston*. Geol. Mag., dec. 3, vol. i, p. 299, pl. ix, fig. 10.
1885. — minuta, *Sow*. Cossmann, Ét. Bath., p. 154, pl. xiii, figs. 30, 31.

Bibliography, &c.—There has been much trouble in regard to the synonymy of this well-marked species, first described by Sowerby from the Great Oolite of Ancliff. But it seems to me that this confusion has been intensified through the view taken by d'Orbigny in the 'Terrains Jurassiques' (vol. ii, p. 231) that *Nerita minuta*, Sow., is the young stage of the costate species. I quite agree that Morris and Lycett were not correct in their identification of Sowerby's *Nerita*

[1] 'Étage Bathonien,' p. 151.

minuta, as pointed out by Cossmann (*loc. cit.*), but that is a very different thing from our accepting the view that *Nerita minuta* and *Nerita costata* are different stages of the same species. The figures of d'Orbigny are altogether beside the mark, as his artist evidently had no idea whatever of *Nerita costata*. Specimens from the Pea-grit, except as to size, very much resemble the Ancliff fossil, and we can trace the costate form in the very earliest whorls. Consequently, as far as the Inferior Oolite is concerned, I cannot agree to the union of these two species of Sowerby, and must continue to regard *Nerita minuta* as a distinct fossil. The *Nerita minuta* figured by Cossmann is evidently Sowerby's *Nerita costata* = *costulata*, Deshayes.

Description :

Height	average 9 mm.
Width	11—12 mm.

Shell transversely ovate, tumid, moderately thick; variable in size, but rarely exceeding 15 mm. in width. Spire small and depressed, consisting of about two and a half whorls, which are costated and sunk in a deep sutural channel. Body-whorl relatively large, constituting about nine-tenths of the total height, and flattened posteriorly so as to impart a certain degree of angularity to the shell, which is ornamented throughout with numerous and rather fine radial costæ, closely set and deflected posteriorly. Aperture large; columellar lip wide and flat, but without denticulation of the inner margin.

Relations and Distribution.—This species may be regarded as one of the most typical Nerites occurring in the Lower Oolites. The most numerous and best preserved specimens occur in the Pea-grit of Crickley Hill, where they are seen to differ somewhat in shape; here and there a specimen being unusually transverse, as though approaching the contour of *Nerita Buvignieri* of the Great Oolite. The shorter specimens exhibit a tendency to merge into the species next described. In the Yorkshire beds *Nerita costulata* is rare, being generally represented in the Dogger by *Nerita pseudo-costa* (perhaps only a variety), whilst in the Scarborough Limestone it seems to pass into a more rugose form.

266. NERITA PSEUDO-COSTATA, *d'Orbigny*, 1850. Plate XXVIII, figs. 7, 8, and 9.

1829 and 1835.	NERITA	COSTATA, *Sow.*, sp.		Phillips, Geol. Yorks., pt. 1, pl. xi, fig. 32.
1850.	—	PSEUDO-COSTATA, *d'Orb.*		Prod., i, p. 264 (*non* Gmelin, 1789). Blue Wick.
1854.	—	—	—	Morris, Cat., p. 264. Blue Wick.
1884.	—	—	—	Hudleston, Geol. Mag., dec. 3, vol. i, p. 298, pl. ix, figs. 7, 8, and 9.
Cf. also	—	COSTIFERA, *Piette.*		Cossmann, Ét. Bath., p. 156, pl. xvii, figs. 59 and 60.

Bibliography, &c.—This species or variety was first noticed by Phillips, who referred it to the *Nerita costata* of the 'Mineral Conchology.' D'Orbigny re-named it *N. pseudo-costata*, and by that name this rather abundant Dogger shell has generally been known to British palæontologists. Not quoted in the 'Terrains Jurassiques.'

Description.—The width and height are nearly equal, the height of a full-sized specimen being about 9 mm. In other respects the shape of the shell as in the preceding species. The flanks of all the whorls are ornamented with very strong radial costæ, regular, and separated by sulci about twice the width of each rib.

Relations and Distribution.—This form can be regarded as little more than a variety of the preceding species, somewhat less transverse in shape, and with stouter and fewer ribs. It replaces *N. costulata* in the Yorkshire Dogger, and occurs very sparingly in the Pea-grit of Crickley. It is not improbable that *Nerita costifera*, Piette, from the Bathonian of Rumigny, is a micromorph of this species on a higher horizon.

267. Nerita subrugosa, sp. nov. Plate XL, figs. 7 *a*, 7 *b*, 8.

Description :

Height	8 mm.
Width	9·3 mm.

Shell transversely ovate, angulated, rather higher than wide, thick; spire short, few-whorled, whorls sunk in a deep channel. Body-whorl relatively large, flattened and angulated posteriorly, and provided with a carina of moderate salience, which is situated rather above the middle of the whorl. Costæ fine, regular, and numerous, and exhibiting slight nodes on crossing the median carina. Aperture very wide, columellar area flattened; other indications wanting.

Relations and Distribution.—*Nerita subrugosa* is a form intermediate between *Nerita costulata*, Desh., and *Nerita rugosa,* Morris and Lycett. From the former it differs in its more angular outline, in the development of a median carina, and in the finer and more closely-set costæ.

The specimen figured (Plate XXVIII, fig. 6) in the present work, from the Scarborough Limestone, probably represents a sort of a passage between *N. costulata* and *N. subrugosa*, where there is a very slight tendency to a median carina. On the other hand, *Nerita rugosa*, M. and L., is less transversely ovate, has a higher spire, and the median carina is much more strongly developed; it is in fact altogether a coarser shell.

Nerita subrugosa has been found sparingly in the Scarborough Limestone at

Scarborough, and in the Northampton Sand at Duston, thus appearing on two different horizons of the Inferior Oolite.

The smooth Nerites—*Neridomus*, Morris and Lycett.

There is more than ordinary difficulty as regards nomenclature in this group, part of which has originated in the interpretation placed upon that very troublesome and obscure micromorph, *Nerita minuta*, Sow. I have endeavoured to focus the smooth Nerites of our Inferior Oolite under two names. There are also a few forms which could not be thus arranged, but as the indications are obscure I have concluded not to attempt them.

268. Nerita (Neridomus) tumidula, *Phillips*, 1829. Plate XXVIII, figs. 12 *a*, 12 *b*.

1829 and 1835. Natica tumidula, *Phil.* Geol. Yorks., pt. i, pl. xi, fig. 25. (*Nerita minuta*, Min. Conch., pl. cccclxiii?).
1854. — — — Morris, Cat., p. 262.
1884. Nerita minuta, *Sow.*, var. tumidula, *Phil.* Hudleston, Geol. Mag., dec. 3, vol. i, p. 296, pl. ix, figs. 4 *a*, 4 *b*, 5 *a*, 5 *b*, 6.

Bibliography, &c.—Morris in his Catalogue, it would seem, did not favour the view that "*Natica*" *tumidula*, Phil., was to be regarded either as a synonym or variety of *Nerita minuta*, Sow. On the other hand, the Yorkshire fossil has been labelled *Nerita minuta*, Sow., in the Lycett collection of the Jermyn Street Museum, presumably in accordance with the identification of Lycett himself.

Description.—Measurements of a specimen from the Dogger: height 11 mm., width 11 mm.

Shell ovate, tumid, smooth, and but slightly oblique, the height and width being nearly equal. The spire is composed of a small button-like apex, expanding in the course of two or three widely separated volutions into a large body-whorl, which exhibits a slight posterior flattening, whilst the rest of the whorl is globose, and without ornament other than fine lines of growth. No colour markings are visible in the Dogger shells, the matrix not being favorable.

Aperture large, outer lip crescent-shaped and thin; inner lip thick, subconvex, and slightly sinuated, without denticulations on the margin. N.B.—In the majority of specimens, as in the one figured, there is a slight abrasion of the

anterior extremity of the aperture, thus producing a somewhat Naticoid aspect. It may have been the above peculiarity which induced Phillips to regard this species as a *Natica.*

Pl. XXVIII, figs. 11 *a*, 11 *b*. *Variety* from the Pea-grit of Crickley, almost identical with *Nerita ovata,* Römer ('Nordd. Oolith.,' p. 156, pl. x, fig. 6). Specimens are a little larger than those from the Dogger, and are somewhat more transversely ovate. The callus on the inner lip is subconvex, thus bringing the shell within the definition of *Neridomus.* The colour markings, often well preserved, are suggestive of *Neritina;* cf. also *Neritina Cooksonii,* Desl.

Relations and Distribution.—In addition to the above a few small shells, about the size of buckshot, occur in the Lincolnshire Limestone both at Weldon and at Ponton, and also more rarely in the Cotteswolds. Because they are small they are sometimes named *Nerita* "*pulla.*" They are probably micromorphs of *N. tumidula,* which is the representative on this horizon of *N. ovata,* Röm., if not absolutely identical. A small species in the Great Oolite of Minchinhampton, described by Morris and Lycett ('Grt. Ool. Moll.,' p. 58, pl. xi, figs. 19, 19 *a*) as *Nerita minuta*, Sow., may be ranked in the same category.

269. NERITA (NERIDOMUS), transverse species. Plate XL, figs. 9 *a*, 9 *b*.

Description :

Height	12·6 mm.
Width	14·3 mm.

Shell transversely ovate, tumid, moderately thick ; spire low, occupying about one-tenth the height of the entire shell, and formed of about two and a half whorls widely separated by the suture, which is canaliculate at the junction with the body-whorl. This is extremely ventricose, only slightly flattened posteriorly, and sloping. Aperture large, with a thin hemispherical outer lip, whilst there is a very wide and convex (*Neridomus*) callus on the columellar lip, the margin of which is nearly straight and not denticulated. Colour markings are often well preserved ; these resemble the markings shown on Pl .XXVIII, fig. 11 *a*.

Relations and Distribution.—Throughout the various horizons in the Oolitic rocks we distinguish an ovate and also a transverse form of Nerite. Such a transverse form as the one figured in Pl. XL is met with sparingly in the Oolite Marl horizon of the Cotteswolds, and also in the Dogger at Blue Wyke. It is more transverse than *Neritina Cooksonii*, Desl., yet not precisely like the *Nerita transversa,* von Seebach, of the Upper Oolites. The species is marked in my collection as *Neritina* "*subtransversa.*"

Genus—Pileolus, G. B. Sowerby, 1823.

Shell limpet-like above, with a subcentral apex; concave beneath, with a narrow semilunar aperture, having a raised border and a columellar disc, surrounded by a broad and continuous peristome. Apex not spiral; shell provided with a columellar septum.

According to the original diagnosis of this singular genus, Sowerby regarded it as possessed of a short internal spire, and this statement is repeated by Morris and Lycett. There does not seem any reason, however, to suppose that *Pileolus* possessed an internal spire, although the plications shown in the enlarged section (Pl. XXVIII, fig. 16) in the region to the left of the columellar septum are somewhat imitative of one.

Fischer speaks of the apex as being subcentral, not spiral. Mr. B. B. Woodward also, in a recent communication to the Zoological Society,[1] observes that this genus most clearly possesses a septum, as in *Neritina crepidularia* and *Tomostoma*, and that there is no true internal spire.

270. Pileolus plicatus, *G. B. Sowerby*, 1823. Plate XXVIII: var. A, figs. 13 *a*, 13 *b*; var. B, figs. 14 *a*—*c*. Enlarged section, fig. 16.

1823.	Pileolus plicatus, *G. B. Sowerby.*	Genera of British Shells, No. 19, figs. 1—4.
1823.	— — *J. Sow.*	Min. Conch., pl. ccccxxxii, figs. 1—4.
1851.	— — *Sow.*	Morris and Lycett, Great Ool. Moll., pt. i, p. 60, pl. ix, figs. 36, 36 *a*—*c*.
1854.	— — *G. Sow.*	Morris, Cat., p. 268.
? Syn.	Patella costulata, *Münst.*	Goldf., Petref. Germ., pl. clxvii, fig. 9.

Bibliography, &c.—The type of *Pileolus plicatus* was obtained from the Great Oolite of Ancliff; the species is also well known, though far from common, in the Great Oolite of Minchinhampton. Morris quotes both this and *P. lævis* from the Inferior Oolite of the same district, and other authors, including Witchell (' Geology of Stroud,' p. 47), make mention of these two species as occurring in the Inferior Oolite of the Cotteswolds. I have not seen specimens from the Cotteswolds, but the specimens from Lincoln, figured in the accompanying plate, differ considerably from the form prevailing in the Great Oolite of Minchinhampton.

[1] " On the Mode of Growth and the Structure of the Shell in *Velates conoideus*, Lamk., and other Neritidæ," ' Proc. Zool. Soc.,' June 14th, 1892.

At Lincoln I recognise two varieties, each of which differs more or less from the Minchinhampton shell.

Description, var. A (fig. 13):

Height	2·75 mm.
Basal length	6·50 mm.

Shell suborbicular, with a sharp subcentral apex of low elevation. The radiating ribs are about eighteen in number, the four posterior ones being more elevated and wider apart than the others. The indications as to the base are not good, so that one cannot say whether the margin is serrated or otherwise.

This form is much more depressed and of smaller habit than the one which prevails in the Great Oolite, whilst the ribs are fewer in number and relatively larger.

Var. B (fig. 14):

Height	3·50 mm.
Basal length	8·50 mm.

This form, which is more abundant at Lincoln than var. A, has a higher and blunter apex, the whole shell being more cap-like. Four or five conspicuous costæ occupy the posterior area, whilst the indications of costæ in the anterior portion of the shell are usually indistinct. A few coarse serrations are noticeable in the posterior portion of the margin, the rest of which is smooth.

In height and shape var. B resembles the typical *P. plicatus*, but the costæ are less numerous. There are also some indications of difference in the base, the position of the cushion not being exactly the same. So far as I can ascertain the inner lip is not crenulated, as stated by Sowerby; Morris and Lycett make no mention of this feature.

Relations and Distribution.—Pileolus plicatus may be accepted as a sort of generalised term for costate forms of the genus. Strictly speaking, I consider that there are two forms at Lincoln, which so far differ from the regular Bathonian *P. plicatus* as to be possibly entitled to rank as two distinct species. But, in order to establish these, more favorable conditions for comparison are required.

The Pea-grit horizon of the Cotteswolds and the "Base bed" at Lincoln are the only places in the Inferior Oolite of this country where *Pileolus plicatus* and its varieties are known to occur.

271. Pileolus lævis, *G. B. Sowerby*, 1823. Plate XXVIII, figs. 15 *a—c*.

1823. Pileolus lævis, *G. B. Sowerby*. Genera of Shells, No. 19, figs. 5—8.
1823. — — *J. Sow.* Min. Conch., pl. ccccxxxii, figs. 5—8.

1851.	PILEOLUS LÆVIS, *Sow.*			Morris and Lycett, Great Ool. Moll., pt. i, p. 60, pl. ix, figs. 37, 37 *a*, 37 *b*.
1852.	—	—	—	d'Orbigny, Terr. Jur., ii, p. 240, pl. ccciv, figs. 1—4.
1854.	—	—	*G. Sow.*	Morris, Cat., p. 268.
? Syn.	PATELLA MAMMILLARIS, *Münst.*			Goldf., Petref. Germ., pl. clxvii, fig. 10.

Description:

Height	1·35 mm.
Basal length	7 mm.

Shell elliptical, extremely depressed, apex subcentral; surface smooth, or only marked with indistinct furrows; the cushion is central; there are no indications of any crenulation on the inner lip.

Relations and Distribution.—It is not possible fully to verify Sowerby's diagnosis either for this or the preceding species. Morris and Lycett recognise the form in the Great Oolite of Minchinhampton. D'Orbigny's figure may represent this species, though it is too orbicular.

A single specimen from the "Base bed," Lincoln. Quoted from the Inferior Oolite of the Cotteswolds by Morris and by Witchell.

Family—NERITOPSIDÆ.

"*Shell neritiform or naticiform, imperforate, solid; aperture entire, semilunar or oval; lip arched; columella slightly excavated, internal septa not entirely absorbed. Operculum calcareous, thick, non-spiral.*"—FISCHER.

This family is limited to the genera *Neritopsis* and *Naticopsis*, whose opercula have in former days puzzled alike the Mesozoic and Palæozoic palæontologist.

Genus—NERITOPSIS, Grateloup, 1832.

Shell imperforate, subglobular, neritiform, solid, few-whorled; spire short; surface ornamented with spiral bands and axial ribs or striæ. Aperture semicircular, entire, columellar side not denticulated, excavated towards the middle; lip simple, thick. Operculum scutiform, not spiral; upper surface provided with a wide truncated appendix which fits into the columellar notch.—Modified after FISCHER.

It must be admitted that none of the specimens figured in illustration of this Monograph, though as good as any which can be procured on this side of the Channel, exhibit the columellar notch so characteristic of *Neritopsis*. Moreover

the operculum of *Neritopsis Bajocensis* (Pl. XXVII, fig. 10) shows no very obvious signs of the process which should fit into the notch. Hence it must be remembered that, so far as the Inferior Oolite of this country is concerned, one of the most characteristic features in the diagnosis of the genus *Neritopsis* is wanting. The most probable explanation is that the feature has been obscured through the accidents of fossilisation; but the absence of this character has induced some conchologists of eminence, such as the late Robert Bell, to regard these forms as belonging to *Narica* (*Vanikoro*).

Several species of *Neritopsis* are noticed by Moore as occurring in the Upper Lias, and he also described *Neritopsis cancellata*, Moore, from the Lower Lias of Brocastle. Seeing that specific differences, both in the Lias and Oolites, are mainly based on variety of ornamentation, which evidently varied according to locality as well as according to horizon, the precise biological value of these distinctions may not be very great. In the Inferior Oolite of Dorsetshire specimens run much larger than in other districts, but, on the whole, *Neritopsis*, though far from being abundant, is by no means confined in its distribution.

272. NERITOPSIS BAJOCENSIS, *d'Orbigny*, 1850. Plate XXVII, figs. 9 *a*—*c*. Operculum, fig. 10.

1850.	NERITOPSIS	BAJOCENSIS,	*d'Orbigny*.	Prod., i, p. 264.
1852.	—	—	—	Terr. Jur., vol. ii, p. 223, pl. ccc, figs. 8—10.
1867.	—	—	—	Laube, Gast. Br. Jura von Balin, p. 6, pl. i, fig. 9.
Non	—	—	—	Hudleston, Geol. Mag., dec. 3, vol. i, p. 300, pl. ix, fig. 11.

Description:

Height of a medium specimen . . .	23 mm.
Width	26 mm.

The following is the author's diagnosis:—"Shell oval, transverse. Spire very short, composed of three very convex whorls, excavated near the suture, increasing very rapidly, of which the last, of enormous size, is furnished spirally with numerous small alternate unequal costæ, and with radial undulations, like rounded furrows."

Relations and Distribution.—This species is especially characterised by the thick undulating costæ on the rounded shoulder of the body-whorl. It is essentially a fossil of the Upper Division of the Inferior Oolite, and is almost

restricted in this country to the *Parkinsoni*-zone of Burton Bradstock, where it occasionally attains a large size.

273. Neritopsis Philea, *d'Orbigny*, 1850. Inferior Oolite variety, Plate XXVII, figs. 11 *a*, 11 *b*, 11 *c*.

	1850.	Neritopsis Philea, *d'Orbigny*.	Prod., i, p. 247.
	1852.	— — —	Terr. Jur., vol. ii, p. 222, pl. ccc, figs. 5—7.
Cf. also		— Bajocensis, *d'Orb.*	Hudleston, Geol. Mag., dec. 3, vol. i, p. 300, pl. ix, fig. 11 (Dogger variety).

The Dogger specimen above referred to was described by me as an intermediate form, and it belongs to the variety figured on the accompanying plate (XXVII, 11), which is the prevailing form in the *Concavus*-bed at Bradford Abbas, where it sometimes attains a width of nearly 40 mm. It has the flattened shoulder and spiral ornamentation of *Neritopsis Philea*, and is devoid of the thick radial costæ so characteristic of *N. Bajocensis*. The "rampe postérieur," however, is scarcely developed in this variety, and the ornamentation generally is finer. Occasionally a specimen which corresponds almost exactly with d'Orbigny's figure and description may be found in the *Concavus*-bed. To these the name *N. Philea* may be applied without hesitation. If it is desirable to recognise the variety I would suggest *Neritopsis Philea*, var. *Abbas*.

274. Neritopsis varicosa, *Morris and Lycett*, 1851. Plate XXVIII, figs. 1 *a*, 1 *b*, 1 *c*.

1851.	Neritopsis varicosa, *Morris and Lycett*.	Great Ool. Moll., pt. i, p. 106, pl. xi, figs. 20, 20 *a*; pl. xiii, fig. 5.
1854.	— — —	Morris, Cat., p. 265.

Description:

Height of a full-sized specimen . .	13·5 mm.
Width	16·5 mm.

The following is the diagnosis by the authors:—"Shell neritiform, ovately oblong; varices large, longitudinal (about ten in a volution), more or less elevated, decussated, with numerous regular, elevated, and transverse (spiral) lines; the lines are impressed with extremely fine and dense perpendicular striæ; the aperture round."

Relations and Distribution.—This species is related to *N. Bajocensis*, from

which it may be distinguished by its uniformly smaller habit, by its more transverse shape, and by the fact that the longitudinal (*i. e.* radial) varices are relatively larger and extend across the entire body-whorl. But, as noted by the authors, the varices vary much in magnitude, so that in some specimens they are nearly obsolete. Under these circumstances the shells are not easily distinguished from *Neritopsis*, cf. *decussata*, Münster.

Although regarded by Morris and Lycett as a Great Oolite species, I am somewhat doubtful of the occurrence of *Neritopsis varicosa* in the Great Oolite of Minchinhampton. On the other hand, it occurs not unfrequently in the Oolite Marl of the Cotteswolds, and more rarely in the Pea-grit.

275. Neritopsis, cf. decussata, *Münster*, 1844. Plate XXVIII, figs. 5 *a*, 5 *b*, 5 *c*.

1844. Natica decussata, *Münst.* Goldfuss, Petref. Germ., pl. cxcix, fig. 10. As a species from the Coral Rag.
1852. Neritopsis decussata, *Münst.* D'Orbigny, Terr. Jur., vol. ii, p. 227, pl. ccci, figs. 8—10.

The species described above (*N. varicosa*) gradually shades off into cancellated forms such as those figured in the accompanying plate. I might also refer to *Neritopsis cancellata*, Moore ('Quart. Journ. Geol. Soc.,' vol. xxiii, p. 548, pl. xv, fig. 20), and to some of the forms described under *N. Guerrei*, Héb. and Desl. ('Bull. Soc. Linn. Norm.,' vol. v, p. 185, pl. i, fig. 4). Cancellated forms of this kind seem to occur on more than one horizon. There are two specimens from the "Base-bed" at Lincoln, one of which is figured in the accompanying plate. The aperture is somewhat more angular on the columellar side than usual.

276. Neritopsis incisa, sp. nov. Plate XXVIII, fig. 2.

Description:

Height . . . . . 12·5 mm.
Width . . . . . 16 mm.

Shell transversely ovate-oblong; spire extremely few-whorled and very low. Body-whorl relatively enormous, with a somewhat flattened posterior area. The ornaments consist of about ten or twelve extremely rugose radial ribs, irregularly developed and divided by deeply-cut sulci. These are decussated throughout by

numerous coarse spiral bands, forming very prominent nodes at the intersections. Aperture nearly circular.

Relations and Distribution.—From *Neritopsis varicosa*, M. and L., this species may be distinguished by its more angular and transverse form, by the almost aborted spire, and by the exaggerated character of the radial costæ. It is nearly related to *Neritopsis Hebertana*, d'Orb., and might perhaps be regarded as little more than a variety. The spiral belts are more numerous and less salient than seems to be the case with d'Orbigny's species.

This bizarre form was first noticed in the "Base-bed" at Lincoln, whence I have obtained some characteristic specimens since the one figured on the accompanying plate was drawn. A single specimen from the *Nerinœa*-bed in the Pea-grit at Crickley.

277. Neritopsis, cf. hebertana, *d'Orbigny*, 1852. Plate XXVIII, figs. 3 *a*, 3 *b*, 3 *c*.

1852. Neritopsis Hebertana, *d'Orbigny*. Terr. Jur., vol. ii, p. 221, pl. ccc, figs. 1—4.

Description:

Height	12·5 mm.
Width	15 mm.

Shell transversely oblong, angular, thick; spire very short, composed of two or three angular and rugosely ornamented whorls set in a sutural hollow, and developing into a relatively enormous body-whorl, which is transversely oblong and very angular. Four extremely prominent spiral bands are decussated by radial costæ of nearly equal strength; the points of intersection are marked by nodes which must have been extremely spinous. Aperture subcircular and wide, but not sufficiently preserved in the available specimens for correct diagnosis.

Relations and Distribution.—There is something in this form not exactly like *Neritopsis*, and yet on the whole I think it must be regarded as an extremely rugose relative of *Neritopsis Hebertana*. There are two specimens from Stoford (North Dorset), and I have seen two more, which are stated to have come from the Inferior Oolite at Bathford.

278. Neritopsis, cf. sulcosa, *d'Archiac*, 1843. Plate XXVIII, fig. 4.

1843. ? Nerita sulcosa, *d'Archiac*. Mém. Soc. Géol. France, vol. v, pt. 2, p. 377, pl. xxviii, fig. 10.
1851. Neritopsis sulcosa, *d'Archiac*. Morris and Lycett, Great Ool. Moll., pt. 1, p. 59, pl. xi, fig. 12.
1884. — — — Cossmann, Ét. Bath. (Mém. Soc. Géol. France), p. 159, pl. iii, figs. 15—17.

Attention is called to a specimen from the *Nerinæa*-bed in the Pea-grit of Crickley, which has considerable resemblance to this Bathonian species. The Inferior Oolite specimen is somewhat squeezed out of shape, but the ornamentation is similar to that of *N. sulcosa*. It might also be regarded as a modified form of the fine variety of *Neritopsis Philea*.

279. "Neritopsis lævigata." Plate XXVIII, fig. 10.

1885. Neritopsis (? Turbo) lævigata, *Phil.*, pars. Hudleston, Geol. Mag., dec. 3, vol. ii, p. 49, pl. ii, fig. 2. *Non* figs. 1, 3, 3 *a*.

Since the Dogger shell, represented in the accompanying plate, was originally figured, evidence has been obtained which renders it probable that this form should be separated entirely from *Turbo lævigatus*, Phil.

A very similar and possibly identical form occurs at Duston in the Northampton Sand. These shells are transversely ovate, globose, and thick, averaging 22 mm. in height and 26 mm. in width. The very small spire consists of from two to three smooth and rounded whorls, the whole shell suddenly expanding into an enormous body-whorl, the sutures being rather close. The posterior area of the body-whorl is subtabulate, the sides ventricose, and the ornaments consist of fine spiral striæ decussated by growth-lines. Aperture large and semilunar; character of the inner lip uncertain.

It cannot be affirmed with certainty that this species really is a *Neritopsis*. The Duston shells seem related to a very large form of *Natica* or *Ampullina*, which occurs in the Lincolnshire Limestone, and which I have hitherto considered as being identical with *Natica cincta* (*Leckhamptonensis*). On the whole, "*Neritopsis levigata*" cannot be regarded as an established species.

Family—TURBINIDÆ.

"*Shell spiral, turbinated or pyramidal, nacreous inside; operculum calcareous and pauci-spiral, or horny and multispiral.*"—S. P. Woodward.

The above diagnosis includes the Turbinidæ, Trochidæ, and Delphinulidæ of other authors, and, as far as Jurassic fossils are concerned, where the nacreous layer is generally destroyed and opercula hardly ever to be found, cannot be followed very closely.

The withdrawal of *Amberleya* and the so-called "*Littorina*" reduces the number of shells remaining to be considered under this family. These are for the most part small. Whatever generic names are adopted, we recognise two groups, viz. a group of smooth and a group of richly sculptured shells.

Group I.—*Smooth Shells.*

The smooth and generally small Turbinidæ of the Jurassic Rocks have been variously classified. The following are amongst the genera which have been invoked: *Ataphrus, Crossostoma, Chrysostoma, Monodonta, Pleuratella, Plocostylus, Rotella, Teinostoma, Trochopsis, Trochus,* and *Turbo.*

In the Inferior Oolite of this country I think that the smooth Turbinidæ may be focussed, provisionally at least, under three genera. Apart from one or two forms which it may be convenient to arrange under *Turbo* (Section 1), the rest of the shells exhibit a sequence from the most depressed form—*Crossostoma Prattii*, to the most acutely trochiform Monodontoid, viz. *Ataphrus Acis.* Mr. Tawney, it may be remembered, only recognised two species in his 'Dundry Gasteropoda,' viz. "*Monodonta*" *lævigata*, Sow., and "*Monodonta*" *Acmon*, d'Orb.

Genus—Crossostoma, *Morris and Lycett*, 1851.

"*Shell thick, turbinated, smooth, somewhat depressed or rotelliform; whorls more or less flattened, few; apex of the spire obtuse, depressed; aperture nearly circular, entire; the columella forms at its base a simple prominent obtuse tooth; the outer lip is smooth; there is no umbilicus.* . . . ."—Morris and Lycett.

Lycett, in notes and corrections to the 'Supplement,' p. 153, withdrew

Crossostoma discoideum and *C. heliciforme*, which he finally regarded as adult and discoidal forms of smooth "Monodontas," leaving only *Crossostoma Prattii* as the representative of the genus. This fossil was said to have come from the Inferior Oolite near Bath. I have not succeeded in obtaining a sight of the type. The genus is held to include *Crossostoma* (*Delphinula*) *reflexilabrum*, d'Orb., from the Lias.

280. Crossostoma, sp.; cf. *Crossostoma Prattii*, Morris and Lycett, 1851. Plate XXVIII, figs. 17 *a*, 17 *b*.

1851. Crossostoma Prattii, *Morris and Lycett*. Great Ool. Moll., pt. 1, p. 72, pl. xi, figs. 21, 21 *a*.
Cf. also Rotella macrostoma, *Stoliczka*. Hierlatzschicten, p. 178, pl. iii, fig. 5.
Teinostoma Neumayri, *Gemmellaro*. Faune Giuresi, &c., p. 344, pl. xxvii, figs. 15, 16.

Description.—Shell thick, nearly twice as wide as high, discoidal; spire greatly depressed. The width of the figured specimen is 15 mm., and of a smaller one, which I possess, 10 mm. The body-whorl is essentially rotelliform, the aperture small and circular, and there is a considerable thickening towards the columellar extremity.

N.B.—There is no umbilicus, as might possibly be inferred from the figure.

Relations and Distribution.—The probable relations of this very discoidal shell are indicated in the list of references. It may be *Crossostoma Prattii*, but if so the figure in the 'Great Oolite Mollusca' is not sufficiently discoidal. The form is very rare. The figured specimen is a brown ferruginated fossil, suggestive of Dundry or of some of the Dorset beds. Another specimen in my collection is from the Pea-grit of Crickley. This is much smaller, and altogether more representative of *C. Prattii*, as far as one can judge of that species.

Genus—Ataphrus, *Gabb*, 1869.

The bulk of the smooth "Monodontas" remain to be described, and the question for consideration is—under what genus? Monsieur Cossmann, in his excellent memoir on the 'Bathonian' in France, adopted the genus *Ataphrus*. He attached much importance to the presence of a columellar furrow in the species thus classified by him. Certainly, in the majority of the smooth "Monodontas"

of our Inferior Oolite this feature of a columellar furrow is greatly subordinate to the columellar callosity which generally culminates in a sort of denticle—the small tubercle of Gemmellaro's genus *Plocostylus*. This feature was especially recognised by d'Orbigny in his description of *Trochus Belus* and *Trochus Acmon*, the former of which was regarded by Gabb as typical of his genus *Ataphrus*.

On the whole, it would seem that Gemmellaro's genus *Plocostylus*, slightly modified, would embrace the depressed forms of the smooth "Monodontas" more correctly than *Ataphrus*. But it is desirable to place the trochiform as well as the turbinate "Monodontas" under one genus. This view was adopted by Messrs. Hudleston and Wilson in their 'Catalogue of British Jurassic Gasteropoda.' Notwithstanding certain difficulties, to which allusion has been made, a similar arrangement is adopted in this Monograph. The following diagnosis, although somewhat different from that of Gabb, relates more especially to the fossils of the Inferior Oolite described below. If this diagnosis is inapplicable to *Ataphrus*, we must look for another generic name.

Shell thick, smooth, and generally small, turbinate or trochiform, imperforate; spire obtuse and often much depressed. Body-whorl relatively large, base more or less flattened, aperture subcircular and restricted. The columellar lip is very short and much incrusted, so that the thickening usually assumes the form of a small blunt denticle towards the extremity of the columella. Growth-lines extremely fine and close.

The above diagnosis possesses many of the characteristics of *Plocostylus*, but is more comprehensive, since it includes trochiform species, such as *Ataphrus Acis*. In fact, as far as the Inferior Oolite is concerned, it comprises a regular ascending sequence from ovulate to trochoidal forms. The question of texture is important in defining the genus. In certain matrices these shells present a glabrous appearance, due to the extreme fineness of the growth-lines, which very often are invisible. The glabrous surface, the blunt and obtuse character of the apical region, the full whorls, and the closely fitting suture are distinctive features, quite as much as the columellar callosity, or the furrow with which it is associated.

In assigning specific names I have endeavoured in nearly all cases, even at the risk of stretching a point, to make use of those already in existence, and of these there is a plentiful supply. It need scarcely be said that forms intermediate to those named also present themselves, and are not easy to allocate. There does not seem to be any special relation between the species and the horizon.

281. Ataphrus, cf. lucidus, *Thorent*, 1839. Plate XXVIII, figs. 18 *a*, 18 *b*.

1839. (Rotella) lucida, *Thorent*, sp. *Fide* Cossmann, Étage Bath., p. 277, pl. vii, figs. 1, 2.
Cf. also Plocostylus typus, *Gemmellaro*. Faune Giuresi, p. 346, pl. xxviii, figs. 1 and 2.

The specimen from the Oolite Marl of the Nailsworth district, figured in the accompanying plate, is unique as far as my collection goes. It has a basal diameter of 13 mm.; ratio of width to height as 10 : 7. There is the possibility that this may be nothing more than a megalomorph of *Ataphrus heliciformis*, M. and L. D'Orbigny's figure of *Trochus lucidus* ('T. J.,' ii, pl. cccxiv, figs. 5—7) differs from that given by Cossmann.

282. Ataphrus heliciformis, *Morris and Lycett*, 1851.

1851. ? Crossostoma heliciforme, *Morris and Lycett*. Great Ool. Moll. pt. 1, p. 73, pl. xi, fig. 8.
1863. Monodonta heliciformis, *Morris and Lycett*. Lycett, Suppl., p. 123.
Cf. also — ovulata, *Héb. and Desl.* Foss. Montreuil-Bellay, p. 58, pl. ii, fig. 9.

Bibliography, &c.—Although originally described as a fossil of the Great Oolite, the authors noted that *C. heliciforme* occurred in the middle division of the Inferior Oolite at Leckhampton. *Monodonta ovulata* seems to occupy an intermediate position between this form and the more abundant *Ataphrus lævigatus*.

Description.—In the majority of the specimens the basal diameter is about 10 mm. or rather less; ratio of width to height as 4 : 3, being slightly less depressed than *Ataphrus lucidus*.

The following is the original diagnosis:—"Shell smooth, turbinated, somewhat depressed; spire small, but little elevated; whorls rather convex; aperture elliptical."

Relations and Distribution.—More depressed than *Ataphrus lævigatus*, less so than the preceding species. Occurs at Stoford in Dorset, but principally in the Oolite Marl of the Cotteswolds, and in the *Parkinsoni*-zone of Aston and Notgrove.

283. ATAPHRUS LÆVIGATUS, *Sowerby*, 1818. Plate XXIX, fig. 5; and variety approaching A. BELUS, *d'Orb.*, fig. 6.

1818.	NERITA LÆVIGATA, *Sowerby*.	Min. Conch., pl. ccxvii, fig. 1.
1853.	MONODONTA LÆVIGATA, *Sow.*	Lycett, Proc. Cotteswold Nat. Club, vol. i, p. 71.
1854.	— — —	Morris, Cat., p. 258.
1873.	— — —	Tawney, Dundry Gasteropoda, p. 34 (26).
1885.	TURBO (MONODONTA) LÆVIGATUS, *Sow.*	Hudleston, Geol. Mag., dec. 3, vol. ii, pl. ii, fig. 6.
Cf. also	MONODONTA OVULATA, *Héb. and Desl.*	*Op. cit.*
	CHRYSOSTOMA OVULATA, *Héb. and Desl.*	Laube, Gast. Br. Jura von Balin, p. 13, pl. iii, fig. 3.

Bibliography, &c.—Sowerby's figure is far from being characteristic, as he remarks that "the specimens do not exhibit the columella." Had this been otherwise he would hardly have taken his fossil for a Nerite. Mr. Tawney thought that Sowerby's type was in the Bristol Museum. With reference to this point Mr. Wilson, the present Curator, wrote in 1893, "The types do not appear, after all, to be at Bristol. Our tablet of specimens, so classed, probably gives a good exemplification of Sowerby's species." With this latter remark I quite agree; in the majority of these specimens the denticle is conspicuous.

Description:

Width or basal diameter . .	12—14 mm.
Width to height . . .	5 : 4.

Shell globular, smooth and thick; spire moderately depressed; number of whorls about four; last whorl ventricose, with sometimes a slight posterior flattening; sutures close. Aperture circular and small, with a strong columellar callosity or denticle, associated in some cases with a faint columellar furrow or pit.

Relations and Distribution.—This is the most common form of *Ataphrus* in the Inferior Oolite, and may be regarded as the representative of the turbinate section, where the spiral angle, as far as it can be determined in such obtuse shells, exceeds 90°. There is considerable variety; or, what amounts to the same thing, we are content to place a certain range of forms under one specific designation. These differences are greatly accentuated by the state of preservation, which varies considerably according to the nature of the deposit.

The finest and most characteristic specimens occur at Dundry; but it is to be met with, more frequently perhaps on a low horizon, in many parts of the Inferior Oolite from Dorset to Yorkshire.

Variety in the Lincolnshire Limestone. Cf. TROCHUS BELUS, *d'Orb.*, 'Terr. Jur.,' vol. ii, p. 283, pl. cccxv, figs. 9—12.

This variety (see Pl. XXIX, fig. 6) is smaller and slightly less depressed than average specimens of *Ataphrus lævigatus*. It is, I have no doubt, the form identified ('Quart. Journ. Geol. Soc.,' vol. ix, p. 326) as *Trochus Belus* from Ponton. Extremely abundant also at Weldon. The denticle is usually more conspicuous than in the accompanying figure, where indeed it is scarcely noticeable.

284. ATAPHRUS OBTORTUS, sp. nov. Plate XXIX, figs. 7 and 8.

Description:

Width or basal diameter . . .	10—14 mm.
Width to height	10 : 9.

Shell smooth, thick and gibbous; spire moderately depressed, and consisting of about four or five whorls, of which the penultimate exhibits a remarkable bulge in the anterior portion. Aperture circular and small, with a thick denticle on the columella, succeeded anteriorly by a shallow pit.

Relations and Distribution.—In many places where *Ataphrus lævigatus* occurs this form may also be noticed, though in fewer numbers. It is probably nothing more than a gibbous variety of the common form. I recognise specimens of *Ataphrus obtortus* from Dundry, Beaminster, Mapperton, Stoford, and also from the *Parkinsoni*-zone of Burton Bradstock; also in the Dogger. The interest consists in the fact that this species gradually shades off into less depressed forms, which are difficult to separate from gibbous varieties of *At. Acmon*.

285. ATAPHRUS LABADYEI, *d'Archiac*, 1843. Inferior Oolite varieties. Plate XXIX, figs. 9 and 10.

1843. TROCHUS LABADYEI, *d'Archiac*. Mém. Soc. Géol. France, vol. v, pt. 2, p. 379, pl. xxix, fig. 2.

1850. TURBO LABADYEI, *d'Arch.* D'Orbigny, Prod., i, p. 301.

1851. MONODONTA LABADYEI, *d'Arch.* Morris and Lycett, Great Ool. Moll., pt. 1, p. 68, pl. xi, fig. 2; and var., fig. 11.

1884. ATAPHRUS LABADYEI, *d'Arch.* Cossmann, Étage Bath., p. 279, pl. vii, figs. 5—8.

Cf. also ? MONODONTA LÆVIGATA, *Münst.* Goldfuss, Petref. Germ., pl. cxcv, fig. 5.

CHRYSOSTOMA ACMON, *Laube* (non *d'Orb.*). Gast. Br. Jura von Balin, p. 13, pl. iii, fig. 2.

TURBO (MONODONTA) LÆVIGATUS, *Sow.*; var. BELLULATA, *Bean.* Hudleston, Geol. Mag., dec. 3, vol. ii, p. 53, pl. ii, fig. 4.

Bibliography, &c.—Our Inferior Oolite specimens appear somewhat more elongated than the Bathonian types, yet not so dissimilar but what they may be referred to d'Archiac's species. "*Nerita*" *bellulata*, Bean, which I include here, is perhaps more close to *Monodonta papilla*, H. and D. ('Foss. Mont.-Bellay,' p. 59, pl. iii, fig. 1). In fact, *At. Labadyei*, *At. papilla*, and *At. Acmon* have at least this feature in common, viz. that they are smooth trochiform shells, where the height and width are about equal.

Description :

Height of full-sized specimens . . .	15 mm.
Width, about	15—16 mm.

Shell conoidal, subturbinate, smooth, tolerably thick. Spire elevated, the apex very obtuse. Whorls about six, subconvex and prominent, standing out well from the suture. The body-whorl is large, slightly depressed posteriorly, rounded at the angle, and subconvex in the base. Aperture restricted and almost circular, with a moderate columellar denticle, succeeded anteriorly by a very shallow sulcus or pit.

Relations and Distribution.—Distinguished from *At. Acmon* by the prominence of the whorls. *At. Labadyei*, and the varieties therewith included, are also more widely distributed throughout the Inferior Oolite.

Although in the main a Great Oolite species, *At. Labadyei* occurs in the Lower Division of the Inferior Oolite both in Dorset and in the Cotteswolds. It also occurs in the *Clypeus*-grit and in other localities and horizons; whilst in the Dogger it is represented by the var. *bellulata*, Bean. N.B.—Should there be any disposition to challenge the identification of *At. Labadyei* as an Inferior Oolite species, I would suggest that the forms from the Lower Division be classified as *Ataphrus bellulatus*.

286. Ataphrus Acmon, *d'Orbigny*, 1850. Plate XXIX, figs. 11 and var. fig. 12; var. approaching *Ataphrus papilla*, H. and D., fig. 13.

	1850.	Trochus Acmon, *d'Orbigny*.	Prod., i, p. 265.
	1852.	— — —	Terr. Jur., vol. ii, p. 278, pl. cccxiv, figs. 1—4.
	1873.	Monodonta Acmon, *d'Orb.*	Tawney, Dundry Gasteropoda, p. 35 (27).
	1884.	Ataphrus Acmon, *d'Orb.*	Cossmann, Étage Bath., p. 281, pl. vii, figs. 9, 10.
Cf. also		— Heberti, *Piette.*	Cossmann, *op. cit.*, p. 281, pl. xvii, figs. 43, 44.

Bibliography, &c.—This is essentially a Bajocian form, the types being from Bayeux and Port-en-Bessin; also abundant at Sully; all places where the fossili-

"TURBO."

A certain number of smooth turbinate forms are classed provisionally under *Turbo*.

288. TURBO LÆVIGATUS, *Phillips*, 1829.

1829 and 1835. TURBO LÆVIGATUS (NERITA LÆVIGATA, *Sow.*, Min. Conch.), *Phillips.* Geol. Yorks., pt. 1, pl. xi, fig. 31; and 3rd edit. (1875), p. 330, pl. xi, fig. 31.

1885. NERITOPSIS (? TURBO) LÆVIGATA, *Phil.*, pars. Hudleston, Geol. Mag., dec. 3, vol. ii, p. 49, pl. ii, fig. 3.

Cf. also ? TURBO GIBBOSUS, *d'Orbigny.* Terr. Jur., vol. ii, p. 342, pl. cccxxx, figs. 1—3.
? MONODONTA LÆVIGATA, *Thorent.* Morris, Cat., p. 258.

I must refer to my remarks in the 'Geol. Mag.' restricted to var. B. See also *antea*, p. 344, with reference to "*Neritopsis lævigata.*" It still remains a matter of doubt what the Phillipsian species may be. The specimen from the York Museum, figured in the 'Geol. Mag.' (*vol. cit.*, pl. ii, fig. 3) is, perhaps, the nearest, but the system of undulating spirals seen in that specimen on close inspection is rather puzzling. I have in my own collection a similar but smaller fossil from the Dogger, where such spirals are not noticeable.

? *Variety* from the Lincolnshire Limestone, Pl. XXIX, fig. 1.

Height	6·5 mm.
Width	7·5 mm.
Spiral angle (regular) . . .	95°.

Shell smooth, turbinate, oblique, not umbilicated; spire subdepressed, apex sharp. Number of whorls about five, smooth, tumid, and well marked off by the suture. Body-whorl fully two-thirds the entire height, regularly convex, large and without ornament other than broad growth-lines. Aperture wide and circular, with a rather thin outer lip, and an excavated and slightly encrusted columella, which carries no denticle, but is scored by a double furrow.

Although there is a superficial resemblance to the turbinate forms described above under *Ataphrus*, there are several indications which point to a different genus. Thus the apex is sharp, not obtuse, the spire regular, the sutures are impressed, and the texture, as shown by the broad growth-lines, is coarse. In a second and smaller specimen which I possess these lines exhibit colour-markings. The aperture is wide, and there is no actual denticle.

289. "Turbo paludinoides." Plate XXIX, fig. 2.

Description:

Height	10·5 mm.
Width	10·5 mm.
Mean spiral angle	70°.

Shell smooth, conical, turbinate, imperforate; substance rather thin. The apex is rather obtuse, with a change in the spiral angle about the third whorl. Total number of whorls six or seven, convex, and well marked off by the suture; without ornament, and rather glabrous, though fairly wide growth-lines are visible in some portions of the shell. The body-whorl slightly exceeds one-half of the total height, and is regularly convex throughout, with a full and rounded base. Aperture fairly wide and circular, outer lip thin; columella excavated, but only moderately encrusted, and marked by a narrow sinuous furrow.

It is not intended that this form, though figured, should take rank as a species until we know something more of its true relationships. The aperture is more circular than in *Bourguetia;* at the same time the shell is very thin for a *Turbo*, whilst the sutures are rather too close for a *Paludina*.[1] A single specimen, presumably from the *Concavus*-bed of Bradford Abbas.

290. Turbo (? Ataphrus) lindecolinus, sp. nov. Plate XXIX, figs. 3 and 4.

Description:

Height	9 mm.
Width	7·5 mm.
Mean spiral angle	55°—60°.

Shell conical, turbinate, rather thick, not umbilicated; spire slightly obtuse. Number of whorls six, smooth, convex, and well marked off by the suture. The body-whorl is about half the entire height, smooth, regularly convex, and with no other indication of ornament than curved growth-lines; basal angle rounded, base full and smooth. Aperture subcircular and rather small; outer lip thin and semilunar; columella short and inclined to be straight, with a moderate callus, and in some specimens a slight columellar furrow.

[1] N.B.—There is a bed in the Chipping Norton district, somewhere about the junction of the Inferior and Great Oolites, which yields a species of *Paludina* in considerable quantities.

N.B.—The figured specimen does not exhibit these latter features distinctly.

Relations and Distribution.—This very commonplace little shell seems to differ, as far as I can judge, from any species in the Inferior Oolite, though it may resemble some of the smooth Turbos recognised in the Lias. Notwithstanding the absence of any well-defined denticle, the character of the aperture rather reminds one of *Ataphrus*.

Not very uncommon in the "Base-bed" at Lincoln.

Group II.—*Sculptured Shells.*

One of the most difficult problems which present themselves for solution in Jurassic palæontology is the correct generic classification of the numerous members of the Turbinidæ coming under Group II. Except as regards the genus *Trochus*, which is undoubtedly represented in considerable numbers, the identification of the modern genera, *Monodonta*, *Turbo*, *Delphinula*, &c., is to a certain extent empirical. I have always had an objection to the acceptance of *Monodonta*, but there is safety in *Turbo* as a general term, which may be held to include various sections by some recognised as distinct genera. *Delphinula*, too, has had its advocates, and many species of Jurassic Turbinidæ have from time to time been thus classified. If, then, I continue to use the genus *Monodonta* for Jurassic shells, it is only in a conventional sense, as *Turbo* would do just as well. For the same reason no diagnosis is offered either of MONODONTA, TURBO, or DELPHINULA.

291. MONODONTA PISOLITICA, sp. nov. Plate XXIX, fig. 17 and ? fig. 18.

Description :

Height	4 mm.
Width	3·5 mm.
Spiral angle	65°.

Shell trochiform, thick, imperforate; apex rather obtuse, spiral angle regular. Number of whorls about five; the apical ones are smooth and round, the remainder flat, and ornamented by four tuberculated spirals, which in the body-whorl present some differences, the anterior spiral at the angle of the shell having larger granulations than the others. Body-whorl subangular and rather more than half the total height; base full, and ornamented with granulated spirals rather finer than those at the sides. Outer lip circular; columella nearly straight, and reflexed

towards the anterior extremity, so as to produce a denticulated appearance succeeded by a kind of notch.

Relations and Distribution.—Although there is much in this curious little shell to remind one of *Brachytrema*, I think we must regard it as a member of the Turbinidæ. The form (fig. 18) may represent an aged specimen, or possibly another species. It bears some resemblance to *Monodonta exigua*, Lycett ('Suppl.,' p. 22, pl. xliv, fig. 29), from the Great Oolite.

Monodonta pisolitica is fairly plentiful in the Pea-grit at Leckhampton.

292. Monodonta Lyelli, *d'Archiac*, 1843. Plate XXX, figs. 1 and 2; var. *humilis*, fig. 3.

1843. Monodonta Lyelli, *d'Archiac.* Mém. Soc. Géol. France, vol. v, pt. 2, p. 380, pl. xxix, figs. 8 and 8 *a*; id., var., 8 *b*, 8 *c*.
1850. Turbo Lyelli, *d'Orb.* Prod., i, p. 301.
1851. Monodonta Lyellii, *d'Arch.* Morris and Lycett, Great Ool. Moll., pt. 1, p. 67, pl. xi, fig. 4.
1853. — — — Morris, Quart. Journ. Geol. Soc., vol. ix, p. 326.
1884. — Lyelli, *d'Arch.* Cossmann, Étage Bath., p. 271, pl. vii, figs. 28, 29.

Bibliography, &c.—We have the authority of Morris as to the occurrence of this well-known Bathonian species in the Lincolnshire Limestone, where the forms differ somewhat from those in the Great Oolite of Minchinhampton, and possibly still more from d'Archiac's types. It seems to be an eastern form, being quoted from the Bathonian and Bajocian of Eastern France.

Description :

Height of average specimen . . .	8 mm.
Width	7 mm.
Mean spiral angle	65°.

Shell turbinate, subumbilicate; spiral angle fairly regular, but with a flattened apex; sutures wide and canaliculate. Number of whorls four, the two at the apex smooth, the other two ornamented with from three to four tuberculated spirals, the tubercles having a shallow concave pit on the anterior side.

The body-whorl is subventricose, more or less carinated, and carries three strongly tuberculated spirals on the side, and a fourth, with lesser tuberculations, at the angle. Four more tuberculated spirals ornament the base, including the umbilical cavity, the margin of which is fringed by the one carrying the strongest

row of tubercles. The aperture is subcircular, outer lip lunate and crenulated; columella curved, slightly reflexed and truncated.

Relations and Distribution.—As a rule, specimens from the Lincolnshire Limestone are smaller, less elevated, and more distinctly tuberculated than those from the Great Oolite of Minchinhampton referred to *Monodonta Lyelli.* But they vary also much amongst themselves. A depressed and more carinated form is represented in Pl. XXX, fig. 2, and this tendency is further shown in the var. *humilis* described below.

It is not always easy, when specimens are indifferently preserved, to distinguish between *Monodonta Lyelli* and *Turbo Hamptonensis* (Inferior Oolite variety). Athough for the sake of reference it is convenient to place these in separate genera, so as to change the usual names as little as possible, yet practically they belong to the same genus. *M. Lyelli* may generally be distinguished by the more gaping suture, less regular form, more carinated body-whorl, and by the more irregular character of the ornaments. It seems to be chiefly confined to the upper beds of the Lincolnshire Limestone, notably at Ponton, Barnack, and Weldon. I think, too, that it may be recognised at Hook Norton.

Var. *humilis*, Pl. XXX, fig. 3. More depressed than the preceding; the height averages 4 mm., and the width 5 mm. There are four whorls, the apical ones very depressed; the third whorl is angular and subbicarinate, having two spirals, of which the upper one only is tuberculated. The body-whorl, more than half the entire height of the shell, is large, bicarinate, and furnished with two or three spirals, of which the lower one is often plain; the spirals in the base are finer, except the last, which encircles the umbilicus with a richly tuberculated demilune.

Since the number of whorls is the same, this form cannot be regarded as the young of *M. Lyelli*, but rather as a stunted and local variety, which is itself very variable, and only partly represented in fig. 3 of the accompanying plate. Most of my specimens are from Weldon.

293. Turbo "depressiuscula." Plate XXX, fig. 4.

Description:

Height	5 mm.
Width	8 mm.

Shell obtusely conical, subdepressed, umbilicate; apex obtuse, consisting of two smooth and flattened whorls; third whorl bicarinate with two richly tuberculated spirals, the tubercles being connected by short axial costæ; sutures wide and canaliculate. The body-whorl is angular and strongly bicarinate, having

three tuberculated spirals, one on the posterior margin, and one on each of the carinæ; the tubercles of the first and second spiral are connected across the sloping part of the whorl by axial costæ. Base rather inclined to be flat, and ornamented with four spirals which are finely granulated, except the last, surrounding the circular margin of the umbilicus, where the tuberculations are again larger. The umbilicus is rather wide, and the aperture inclined to be circular, but the indications are not clear.

Apparently related to the more depressed section of *M. Lyelli*, but differing considerably in the ornamentation and shape of the whorls. There is one specimen in the Sharp Collection at the British Museum, most probably from Ponton or Barnack. A second specimen in my own Collection already shows some difference. No others have come under my notice.

294. TURBO "SPATHICA." Plate XXX, fig. 5.

Description:

Height	4·5 mm.
Width	5 mm.

Shell conical, umbilicated, spire elevated, apex obtuse, number of whorls five. To a certain extent this form reminds one of *Turbo delphinuloides*, d'Arch. (*op. cit.*, p. 379, pl. xxix, figs. 3 *a*—*c*). Ours is a smaller and more conical shell than d'Archiac's species, but the angular character of the whorls and the thick radial costæ are points of resemblance. The base is rounded and smooth (radial lines alone being visible)—a feature which at once separates *M.* "*spathica*" from *M. Lyelli* and its relatives.

Two specimens are known to me, both being from the Lincolnshire Limestone, precise locality unknown—probably Ponton, Barnack, or Weldon.

295. TURBO HAMPTONENSIS, *Morris and Lycett*, 1851, Inferior Oolite variety, Plate XXIX, figs. 19 and 20.

1851. TURBO HAMPTONENSIS, *Morris and Lycett.* Great. Ool. Moll., pt. 1, p. 64, pl. ix, fig. 30.

Cf. also — BURTONENSIS, *Lycett.* Supplement, p. 100, pl. xlv, fig. 15.

— (DELPHINULA) FUNICULATUS, *Phil.*, vars. Hudleston, Geol. Mag., dec. 3, vol. ii, p. 54, pl. ii, figs. 7 and 8.

Bibliography, &c.—In adopting the above name I wish to indicate that a certain form is widely, though not abundantly, spread throughout the Lower Oolites, which undoubtedly belongs to the group of which the Corallian species, *D. funata*, Münst., is a member, but yet is not the same species. The question calling for immediate decision is, what shall we call this fossil? On the whole, it seems to me that *Turbo Hamptonensis* may be made to cover the ground with the reserve, " Inferior Oolite variety."

Description.—Height 11 mm., width 10 mm., but variable in this respect; spiral angle 65°. Shell conical, moderately umbilicated. Spiral angle fairly regular, but with a flattened apex. Number of whorls usually five, those at the apex smooth, the others richly ornamented with tuberculated spiral bands, about three in number on the penult and antepenult; sutures wide and in some cases almost gaping.

The body-whorl is about half the entire height, subventricose, and carries four tuberculated spirals on the flank, which is in some specimens somewhat bicarinated. Base rounded and studded with tuberculated spirals, of which the lowest, distinguished by larger granulations, forms a prominent demilune at the margin of the umbilical cavity. The aperture is subcircular, the outer lip thin and crenulated; the inner lip is slightly angular towards the columellar extremity, where there is a sort of thickening.

Relations and Distribution.—The above diagnosis represents a more vigorous form than *Turbo Hamptonensis*, which was described from a single specimen in the Great Oolite of Minchinhampton. A still smaller variety is *Turbo Burtonensis*, from the Forest-Marble. Not always to be distinguished from *Monodonta Lyelli*, and intimately connected with *Turbo Davoustii*, which is probably nothing more than an exaggerated and squamose variety.

Rare in Dorset; occurs at different places and on different horizons in the Cotteswolds. Some of the most characteristic specimens are from the neighbourhood of Hook Norton, where it is not always easy to distinguish it from *Monodonta Lyelli*. Varieties from the Dogger and Cornbrash of Yorkshire have been figured by me in the 'Geological Magazine' (*vol. cit.*).

296. Turbo (Delphinula) Davoustii, *d'Orbigny*, 1850. Plate XXX, fig. 7; and var. *Lindonensis*, fig. 6.

1850. Turbo Davoustii, *d'Orbigny*. Prod., i, p. 266.
1852. — — — Terr. Jur., vol. ii, p. 344, pl. cccxxxi, figs. 7—10.

Bibliography, &c.—This is perhaps the form recognised by Lycett ('Proc. Cotteswold Nat. Club,' vol. i, p. 71) as *Delphinula funata*, Goldfuss, and also by

Witchell ('Geology of Stroud,' p. 51) as a fossil of the Oolite-Marl under the same name. It belongs to the same group, no doubt, and has another relative in *Turbo segregatus*, H. and D. ('Foss. Mont.-Bellay,' p. 57, pl. ii, fig. 10). N.B.—Hitherto I have always quoted *D. funata* as a fossil of the Inferior Oolite in the Cotteswolds on the authority of Lycett and Witchell, but it seems that *Turbo* or *Delphinula Davoustii* is more suitable.

Description :

Height	13 mm.
Width	14 mm.
Spiral angle	75°.

The description given by d'Orbigny is sufficiently near to permit of an approximate identification, although there are some differences of detail. *T. Davoustii* may be regarded as a wide-angled and spinulose relative of *T. Hamptonensis.* It is especially characterised by tuberculations which have semilunar pits of varying depth on the anterior side (a feature also of *D. funata*, Goldf., and of *Turbo* [*Delphinula*] *funiculatus*, Phil.). The character of the base and aperture is also the same, except that the tuberculations are far more vigorous.

The best specimens are from Bradford Abbas, presumably from the higher zones; it is also found at Horton Hill in the *Parkinsoni*-zone, but the specimens are inferior. There are also, in all probability, inferior specimens on other horizons and in other localities of the Cotteswolds.

Variety *Lindonensis* (fig. 6).

Description :

Height	11 mm.
Width	13 mm.
Spiral angle	80°.

Shell turbinate, moderately umbilicated. The spire is convex and irregular, with a gaping suture, especially pronounced in the last whorl. Apex obtuse; number of whorls about four, angular and subtabulate, the whole shell being conspicuously muricated; penult ornamented by three or four rows of spinous tubercles.

The body-whorl is somewhat bicarinate, and has on the flank three rows of very spinous tubercles, hollowed anteriorly; the middle row, which is situate at the posterior angle, carries the largest spines. Base rounded, and ornamented with four or five rows of smaller tubercles. Umbilicus and aperture as in *T. Davoustii.*

Of all the members of the group known to occur in the Inferior Oolite, the var. *Lindonensis* has perhaps the most considerable resemblance to the Corallian

Delphinula funiculata, Phil., which I hold to be very much the same as *D. funata*, Goldf. In the looseness of the whorls it also serves to remind us of *T. segregatus*.

Occurs rather abundantly in the "Base-bed" at Lincoln. Inferior specimens in the Oolite-Marl of the Cotteswolds, rare.

Group related to *Delphinula alta*, Morris and Lycett (Great Ool. Moll., pt. 1, p. 71, pl. ix, fig. 31).

From a purely biological point of view it is probable that the "species" hereunder described are all localised varieties of a generalised form, which might be focussed under the general term *Delphinula alta*—the more so since these variations occur on one horizon, and consequently do not in any way mark time. *Delphinula alta* has been quoted as a fossil of the Lincolnshire Limestone by Mr. Etheridge (Judd, 'Geology of Rutland,' p. 282); but whether or not in reference to the strongly marked fossils from the base of that formation at Lincoln, figured in pl. xxx, I cannot ascertain.

For this group generally cf.—

Delphinula serrata, Buvig., 'Géol. Meuse,' pl. xxiv, figs. 26—29.

— *stellata*, Buvig., *op. cit.*, pl. xxiv, figs. 37—39.

— *hirsuta*, Eug. Desl., MS., Cossmann, 'Étage Bath.,' p. 270, pl. x, figs. 42, 43.

297. Delphinula alta-bicarinata, sp. nov. Plate XXX, fig. 8.

Description :

Height	10 mm.
Width	12 mm.

Shell irregularly turbinate, umbilicate; apex obtuse, the apical whorls being smooth; number of whorls four; sutural space very wide, almost gaping. The penultimate is angular and bicarinate, each angle being marked by a studded belt of tuberculations, those in the upper belt are the strongest.

The body-whorl is large, extremely angular and bicarinate, the carinæ being furnished with large squamous tuberculations, strongest in the upper row, the tubercles being very hollow. Fine and sinuous radial ornamentation pervades the sides, especially on the posterior area, where it is sometimes wrinkled up into a subsidiary carina. The base is much produced, and has three raised spirals, the anterior one

bordering the umbilical excavation being roughly serrated. The umbilical hollow terminates in a true umbilicus of considerable depth. Aperture circular, with an expansion of the inner lip, so as to produce a slight projection towards the columellar extremity.

Relations and Distribution.—This form occurs rarely in the "Base-bed" at Lincoln, and also at Stoke Lodge. I possess a specimen, considerably larger than the one figured, said to have come from the Inferior Oolite of Rodborough Hill.

298. DELPHINULA ALTA-ACANTHICA, sp. nov. Pl. XXX, fig. 9; variety, fig. 10.

Description :

Height	8 mm.
Width	10 mm.

Differs from the preceding chiefly in the more gaping suture, in the freedom from bicarination, which is especially marked in the body-whorl; and, above all, in the great size and length of the spinous processes (hollow) on the single carina situate at the angle of each whorl.

Relations and Distribution.—It is just possible that this form may represent *D. alta*, M. and L., under circumstances which permit of its bizarre ornamentation being preserved.

Excellent specimens are occasionally obtained from the "Base-bed" at Lincoln. Hitherto I have not noticed this particular form elsewhere in the Inferior Oolite.

DELPHINULA ACANTHICA, var. DEPRESSA, fig. 10.

Description.—Height 4·3 mm.; width (without spines) 6·5 mm. Number of whorls the same as in the more usual form, but all extremely depressed. The penult and body-whorl are flattened out, angular, muricated, and furnished with a keel, which produces wide-apart, upturned spines, whose length keeps increasing anteriorly until a very salient projection is attained.

This is the most bizarre of all the forms connected with this group of *Delphinula*. For comparison *vide* list given *supra*. It is just possible that *Euomphalus coronatus*, Sow., may be a micromorph, though, if Sowerby's enlargement is to be relied on, that shell is more likely to be a *Straparollus*.

Rare in the "Base-bed" at Lincoln.

299. Delphinula (Turbo) Buckmanni, *Morris and Lycett,* 1851, Inferior Oolite variety. Plate XXX, fig. 11.

1851. Delphinula Buckmanni, *Morris and Lycett.* Great Ool. Moll., pt. 1, p. 71, pl. v, fig. 8.
1884. Turbo Buckmanni, *Morris and Lycett.* Cossmann, Étage Bath., p. 265, pl. vii, fig. 50.

Bibliography, &c.—The authors speak of *D. Buckmanni* as occurring in the beds of coarse planking on Minchinhampton Common, though it must be rare, as I have never seen any specimens from the Great Oolite except the three in the Jermyn Street Museum, one of which is the type. In none of these are there strong indications of an umbilicus. Quoted by Cossmann from two localities in the Bathonian of France.

Specimens from the Inferior Oolite show a considerable umbilicus. The following relates exclusively to Inferior Oolite specimens, which may possibly represent a distinct species.

Description :

Height	10 mm.
Width	11 mm.
Spiral angle	80°.

Shell turbinate, moderately thick, more or less umbilicated; the spire, which is pointed and conical, occupies about two-fifths of the total height. Number of whorls five; the two apical ones smooth, the next two are carinated anteriorly, and ornamented with a pair of tuberculated spirals, the points of which are joined by thick radial costæ; sutures moderately wide.

The body-whorl is large, angular, and bicarinate; base full. The primary ornaments consist of a tuberculated spiral on the posterior margin, and one on each of the carinæ, these being decussated by a system of thick radial costæ, which extend from the posterior margin of the whorls across the intercarinal hollow, and right across the base to the margin of the funnel-shaped umbilicus; fine spiral striæ, especially conspicuous in the intercarinal hollow, constitute a secondary ornamentation. The aperture is circular, with but little callus on the inner lip. The radial costæ are sometimes continued over the margin of the umbilicus, which varies as to size, being much encroached upon in some of the older shells.

Relations and Distribution.—If this is really the same as the Great Oolite species, the range of *D. Buckmanni* is considerable. In the Inferior Oolite it has only been found, so far as I know, in the Oolite-Marl of the Nailsworth district, whence specimens are occasionally obtained.

N.B.—The remainder of Pl. XXX is occupied with figures of an interesting group of turbinate shells, generally known to me as the *Granata*-group. This group is confined to the Lower Division of the Inferior Oolite, and often to a low horizon such as the *Opalinus*-zone and the lower part of the *Murchisonæ*-zone, but is also abundantly represented in the *Concavus*-bed of Bradford Abbas.

These depressed and highly ornamented "Turbos" are characterised by a large and infundibuliform umbilicus. Interiorly the aperture is circular, but with a subrhomboidal peristome, reminding one greatly of *Delphinula*, a view which is further supported by the character of the umbilicus. Bean seems to have been the first naturalist in this country whose attention was drawn to the subject. Specimens from the Dogger were sometimes named in his MS. *Delphinula granata*, sometimes *Solarium granatum*. Mr. Tawney named a species of this group from the *Concavus*-bed of Bradford Abbas *Turbo Shaleri*. If, on the present occasion, I adopt the double name, it must be understood that "*Turbo*" is only used in a conventional sense, and that to my mind *Delphinula* is nearer the mark. Then comes the question of "species." The relationship of the forms from 12 to 17 figured in the accompanying plate is obvious, and one might select a much larger number of varieties. This is a case where the binomial system of nomenclature is evidently at fault. Whatever specific name is used, in each case the word "*granata*" should be understood.

300. Turbo (Delphinula) Shaleri, *Tawney*, 1873. Plate XXX, fig. 12.

1873. Turbo Shaleri, *Tawney*. Dundry Gasteropoda, p. 31 (23), pl. ii, fig. 3.

Description :

Height	9 mm.
Width	12·5 mm.
Spiral angle	90°—95°

N.B.—The largest specimen from Bradford Abbas does not exceed 14 mm. in width. Specimens from Dundry, according to Mr. Tawney's measurements, seem to be larger.

Shell turbinate, widely umbilicate; the spire is regular in some specimens, gibbous in others, and ranges from one-third to two-fifths the total height. Apex pointed, number of whorls five, sloping easily to a very strong anterior keel, which is richly ornamented with rather fine granulations; in some cases a second keel is exposed in the penult; a fine and almost imperceptible circle of granulations also lines the posterior margin.

The body-whorl is large, angular, and sub-bicarinate, the widest part being at the upper keel, but the difference in width between the upper and lower keel varies considerably. The keels are richly granulated, the granulations in the lower keel being smaller, and the whole surface of the shell is covered by an interlacing network of spiral and radial striæ, the umbilicus being encircled by a row of prominent tubercles rather wide apart. Aperture sub-rhomboidal to circular; umbilicus funnel-shaped and deep.

Relations and Distribution.—There is much variety in the shells classed under *Turbo Shaleri*, chiefly owing to the difference in the amount of exposure in the penultimate—thus producing a figure very different to that of the specimen selected (fig. 12). It is obviously a member of the *Granata*-group, especially characteristic of the *Concavus*-bed, Bradford Abbas. Quoted from Dundry by Tawney, where specimens seem to be less highly ornamented.

301. *Delphinula*, species or variety. Plate XXX, fig. 13.

The specimen figured in the accompanying plate differs so considerably, both from *Turbo Shaleri* and also from the other members of the *Granata*-group, described below, as to be worthy of notice. The opening of the spiral angle is about 115°, the body-whorl is equally bicarinate, and the ornaments are very fine, except where a circle of elongated tubercles borders the wide and funnel-shaped umbilicus.

The specimen is believed to be from the Inferior Oolite of the Dorset district and is unique. As a mere name of convenience I would distinguish it as *Delphinula* "*densistriata*." In shape, but not in ornamentation, it has some resemblance to *Turbo Theodori* (Goldf., t. 179, 1).

302. Delphinula Shaleri, var. pulchrior. Plate XXX, fig. 14.

Description:

Height	12 mm.
Width	16 mm.
Mean spiral angle about . . .	85°.

Shell turbinate, moderately umbilicated, spire fairly elevated, ranging from more than one-third to less than one-half the total height; apex flattened, apical whorls smooth. Number of whorls five, concave, and ornamented by tuber-

culated spirals at the posterior and anterior margins, the interspaces being richly interwoven with fine granular ornaments; sutures regular and canaliculate.

Body-whorl large, subangular and bicarinate, the tuberculated carinæ being equal and approximate; a granulated spiral belt adorns the posterior margin. The tuberculations on the carinæ are radially elongate, and the entire surface of the shell, including the full base, is richly chased with granular spiral ornament. A system of radiating tubercles encircles the somewhat restricted umbilicus; aperture circular to subquadrate.

Relations and Distribution.—Strictly speaking, this may be regarded as a megalomorph of *Turbo* (*D.*) *Shaleri*, although there are many points of difference. Yet varieties classed with *T. Shaleri* seem to lead up to this form, which occurs in the same beds, though more sparingly. Found at Stoford and in the *Concavus*-bed at Bradford Abbas.

303. Delphinula angulata, sp. nov. Plate XXX, figs. 15 and 16.

Description.—There are two well-marked varieties in this species, an elevated form with larger tuberculations (Fig. 15), and a depressed form with finer tuberculations (Fig. 16). It is to the former and more common variety that the subjoined description particularly applies.

Height	11 mm.
Width	14 mm.
Spiral angle	90°—95°

Shell conical, turbinate, umbilicated; spire about one-third the total height, obtuse, but with a sharp apex. Number of whorls five to six, richly ornamented with finely tuberculated spirals at the posterior and anterior margins, the intervening area being very concave; sutures canaliculate, but not very wide.

The body-whorl is very angular, owing to the large and equal double keels, which are rather wide apart. There is a granulated spiral belt on the posterior margin of the body-whorl, and the space between this and the upper keel is very concave; the keels are richly tuberculated, the upper one being rather the stronger; the base is very full and, together with the rest of the shell, spirally striated and slightly decussated. The deep and funnel-shaped umbilicus is encircled by a girdle of axially-extended tubercles, fairly wide apart. Aperture circular to subquadrate.

Relations and Distribution.—Distinguished from *D. Shaleri* and var. *pulchrior* by the very concave whorls, biangular outline, and round or granular character of the tuberculations.

This species is rather widely distributed. The best specimens come from the

Opalinus-zone, at Drympton, and from the lowest *Murchisonæ*-zone at Bradford Abbas and Halfway House. May be noted in the shell-bed below the Lower Limestone at Crickley. It also occurs in the Dogger, and generally in those portions which are below the *Nerinæa*-bed, being, on the whole, a fossil characteristic of a low horizon. By the gradual rounding of the angles and refinement of the ornaments *D. angulata* passes into the species next described.

304. Delphinula (Turbo) granata, *Hudleston*, 1885. Plate XXX, fig. 17.

1885. Turbo (Delphinula) granatus, *Bean, MS.* Hudleston, Geol. Mag., dec. 3, vol. ii, p. 55, pl. ii, figs. 9—12.

Bibliography, &c.—In the description of this species, two varieties were noticed by me. The first of these is more properly *D. granata;* the second variety probably shades off into *D. angulata.*

Description:

Length	11·5 mm.
Width	14 mm.
Spiral angle (variable) . . .	95°.

Shell turbinate and umbilicate; spire rather more than one-third the total height, but variable in this respect, the younger shells being the most depressed. Number of whorls in the full-grown shell five, usually flattened towards the apex. In those cases where the ornaments of the spire-whorls are preserved, tuberculated spirals at the posterior and anterior margins may be noted, but very often adult shells (as in the figured specimen) show scarcely any ornament in the whorls of the spire. In the more gibbous varieties, where a portion of the base of the penultimate is exposed through gaping of the suture, the whorl appears strongly carinated.

Body-whorl large, rounded to subangular and ornamented by a number of tuberculated and granular spiral bands. There is generally a compound spiral band on the posterior margin; the widest part of the shell is marked by a slight carina with conspicuous granulations, below which are other slight keels. The base is very full and granulated, the spiral ornaments terminating in a circle of tubercles round the deep and funnel-shaped umbilicus. Aperture as in the preceding species.

Relations and Distribution.—This is so variable a species that scarcely any two shells are alike. It is more rounded in outline, and the ornaments are of a more granular character than is the case with the forms previously described.

Fairly abundant in the Dogger, *D. granata* is elsewhere represented by allied

rather than by identical forms of the *Granata*-group; although, here and there, as in the "Base-bed at Lincoln and also at Leckhampton, there are micromorphs which may be taken to represent this species. In my own collection "*D. granata*, var.," stands for certain forms of this group. One of the most beautiful of these, apparently between *D. angulata* and *D. granata*, was found by Mr. Wilson in the Inferior Oolite, "Juniper, Painswick."

305. Delphinula (Turbo) Santonis, sp. nov. Plate XXX, figs. 18, 18 *a*.

Description:

Height	9 mm.
Width	9 mm.

Shell conical, turbinate, umbilicated. Spire elevated, spiral angle rather obtuse (about 68°); apex smooth. Number of whorls five, slightly carinated, the ornaments consisted of deep-cut granulated spirals, with one median spiral of moderate prominence, situate at the angle of the whorl; sutures slightly canaliculate.

The body-whorl is full and rounded; it carries three granulated spirals posterior to the keel which is merely indicated by a spiral of larger granulations; below this are two granulated spirals rather more wide apart. The base is full and richly decussated by fine spiral and radial lines, collected into a frill at the margin of the variable umbilicus. Aperture suborbicular, with a slight thickening of the inner lip.

Relations and Distribution.—Notwithstanding its narrower spire, smooth outlines, and *Turbo*-like character, this form must, I think, be classed with the *Granata*-group, and more especially with *D. granata*. There are three specimens in the Jermyn Street Museum from Santon, in North Lincolnshire.

Genus—Trochus, Linnæus, 1758.

Shell conical with an elevated spire, whorls numerous, but slightly convex; spire somewhat pointed; last whorl keeled or angular; base concave, flattened or slightly convex; aperture rhomboidal; lip sharp, very oblique; columella curved, more or less prominent at its union with the outer lip.

The species from the Inferior Oolite classed below under *Trochus* answer fairly to the above diagnosis, though presenting considerable differences amongst themselves. They may be roughly separated into three divisions.

1. Umbilicated species with a somewhat convex base. These forms seem to establish a link with the Delphinulas just described.

2. Species with a nearly flat base, and mostly without umbilicus = *Zizyphinus*.

3. Trochiform shells without umbilicus, some of doubtful nature.

N.B.—There is a group of small umbilicated *Trochi* belonging to the first division, which I might designate the *Sandersii*-group. It so happens that Mr. Tawney founded this species on a single and rather imperfect specimen from Dundry, where probably the form is very rare. In Dorsetshire, however, there is a somewhat numerous group of shells, possessing a general resemblance to the type of *T. Sandersii,* though passing through numerous varieties into something very different. The three following named forms are placed in this group.

306. Trochus Sandersii, *Tawney,* 1873. Dorset variety, Plate XXXI, fig. 1.

Cf. Trochus Sandersii, *Tawney.* Dundry Gasteropoda, p. 31 (23), pl. ii, fig. 4.

Description:

Height	14 mm.
Width	15 mm.
Spiral angle	68°.

Shell conical and moderately umbilicated. Spire about half the total height and rather obtuse towards the apex. Number of whorls about six; those of the spire are concave and marked off by a very wide suture. At the posterior margin of each whorl is a circlet of fine tuberculations, whilst the anterior margin is keeled and marked with a circlet of larger tuberculations; radial costæ cross the intervening hollow.

The body-whorl is concave above and bicarinate below, the upper carina being the most salient; the ornaments are similar in character to those of the spire; base moderately convex with decussated ornamentation; umbilicus deep and somewhat funnel-shaped and encircled by a fringe of tubercles. Aperture sub-rhomboidal.

Relations and Distribution.—The single specimen described by Tawney from Dundry is narrower than the majority of the Dorset shells referred to this species. Nevertheless, these differ among themselves to such an extent that it is not easy to say what the type should be. In Dorsetshire *T. Sandersii, i. e.* the fossils referred to this species seem to occur on a low horizon, chiefly in the *Murchisonæ*-zone or at the base of the *Concavus*-bed.

307. TROCHUS RUPESTRIS, sp. nov. Plate XXXI, fig. 2.

Amongst the forms more or less related to *T. Sandersii* is one from the Irony Nodule-bed at Burton Bradstock, which almost merits to be named as a distinct species, or at least as a variety.

Description :

Height and width	15 mm.
Spiral angle	72°.

The apex is more pointed than in *T. Sandersii*, and the outline more regularly conical. The chief difference lies in the number and position of the spiral belts; the whorls also are less concave, and the base somewhat fuller, and in some specimens the umbilicus is smaller.

Found sparingly at Burton Bradstock, and a variety at Mapperton.

308. TROCHUS SYBILLA, sp. nov. Plate XXXI, fig. 3.

Cf. TROCHUS SEDGWICKII, *Münst.* Goldf., Petref. Germ., pl. clxxix, fig. 4.

Description :

Height	10 mm.
Width	11·5 mm.
Mean spiral angle	75°.

Shell subconical, angulated, slightly umbilicated. The spire, which is rather more than one-third the total height, is very obtuse at the apex. Number of whorls five, well separated by the suture. Close to the posterior margin of each whorl is a circle of tubercles, between which and the principal keel the whorl is concave and sloping; the principal keel is richly tuberculated.

This kind of ornamentation is continued in the body-whorl, which is largely biangulated, owing to the development of a lower tuberculated keel, close to the basal periphery, base moderately full and decussated with spiral and axial lines. In addition to the fine spiral lines which pervade the whole shell, there is a system of radial costæ with posterior deflection. A sweep of elongated tubercles encircles the restricted umbilicus. Aperture subquadrate.

Relations and Distribution.—Differs from *T. Sedgwickii,* Münst., chiefly in the less elevated spire and more stumpy character of the shell generally. In fact, this is a somewhat abnormal *Trochus*, serving to remind us of *Delphinula angulata.* Nevertheless *T. sybilla* is related to *T. Sandersii.*

The small variety figured in the accompanying plate is characteristic of the *Opalinus*-zone of Drympton and Haselbury, and probably of other localities. Some specimens more conical than the one figured I distinguish in my collection as var. *conica*. There is also a large variety in the *Murchisonæ*-zone of Burton Bradstock which comes very near to *T. Sedgwickii*, Münst. It is just possible that a modification of this species—or species-group—from the Dogger is represented in 'Geol. Mag.,' 1885, pl. ii, fig. 13.

309. Trochus Winwoodi, *Tawney*, 1873. Plate XXXI, fig. 4 (minor), fig. 5 (major).

1873. Trochus Winwoodi, *Tawney*. Dundry Gasteropoda, p. 34 (26), pl. ii, fig. 8.

Bibliography, &c.—This species was based upon a single specimen in the Bristol Museum, the locality being uncertain. The author observed that there was some resemblance to Quenstedt's figure of *Trochus bijugatus* ('Der Jura,' p. 485, pl. lxv, fig. 9). Since the year 1873, analogous if not positively identical forms have been found abundantly in the *Concavus*-bed at Bradford Abbas, where the species exhibits great variety. The form is probably derived from the more conical varieties of the *Sandersii*-group, which is, in the main, characteristic of a lower horizon.

Description, var. minor:

Height	19 mm.
Basal width	15 mm.
Spiral angle	47°

Shell regularly conical, elevated, more or less umbilicated. Spire acute and occupying nearly two-thirds of the entire height. Number of whorls seven or eight; these are concave with finely tuberculated keels, not very salient, at the posterior and anterior margins, the intervening space being seamed with granulated spiral striæ somewhat decussated axially; sutures wide and regular.

The body-whorl is similar in shape and similarly ornamented, the second carina forming the angle of the whorl, immediately below which, and partly in the base, is a third subordinate carina. The base inclines to be flat, though rising anteriorly, and is richly ornamented with granular spirals which are partly decussated by axial striæ and growth-lines: a row of slight tubercles girdles the umbilicus, which is sometimes barely indicated. Aperture trapezoidal.

In the variety *major* the ornaments are much coarser, in the whorls of the spire a third carina being exposed. In the body-whorl this attains to considerable importance, so as to produce a duplicate keel at the angle of the shell. The

umbilicus, likewise, is of considerable importance, being deep, though not funnel-shaped; it is encircled by tuberculations of considerable size.

Relations and Distribution of *Trochus Winwoodi.*—Mr. Tawney described his species as having the umbilicus closed, but in point of fact this is hardly ever the case with the specimens from Dorset. Small forms are not very far from the conical variety of *Trochus sybilla*, but the ornaments are always finer, and the shape of the body-whorl different. There are other varieties—almost distinct species.

Abundant in the *Concavus*-bed at Bradford Abbas. Occurs also at Stoford and Halfway House, on or about the same horizon. There is a short conical variety at Beaminster, to which a varietal name might be given.

310. Trochus duplicatus, *Sowerby*, 1817. Plate XXXI, fig. 10.

1817.	Trochus duplicatus, *Sowerby*.	Min. Conch., pl. clxxxi, figs. 5, 5.
1852.	— — —	d'Orbigny, Terr. Jur., vol. ii, p. 275, pl. cccxiii, figs. 5—8.
1867.	— — — ? var.	Laube, Gast. B. J. von Balin, p. 10, pl. ii, fig. 7.
cf. also	— — —	Tawney, Dundry Gasteropoda, p. 32 (24).
Non.	Turbo duplicatus, *Sow.*	Goldfuss, Petref. Germ., pl. clxxix, fig. 2.
Non.	Trochus duplicatus, *Quendstedt.*	Der. Jura., p. 314, pl. xliii, figs. 18, 19.

Bibliography, &c.—The types of *Trochus duplicatus*, *T. angulatus* (*concavus*), and *T. dimidiatus* came from Little Sodbury; these are now in the Sowerby type-collection at the British Museum. The village of Little Sodbury is at the foot of the Cotteswold escarpment and on the Lias; but, as far as I have been able to ascertain, the parish pit in the early part of the century must have been well up the hill and towards the top of the Inferior Oolite. The horizon is doubtless represented in the adjacent quarry on Horton Hill, where the equivalent of the Upper Trigonia-grit of the Cotteswolds (*Parkinsoni*-zone), yields a number of interesting Gasteropoda. *Vide supra*, pp. 57, 58.

Mr. Tawney was, I consider, too comprehensive in his synonymy; for instance, Quenstedt (*loc cit.*) expressly says that the species figured by Goldfuss is not that of Sowerby.

Description:

Height	15 mm.
Width	15·5 mm.
Spiral angle	62°—66°.

Shell regularly conical, moderately umbilicated; spire elevated, considerably

more than half the total height. Number of whorls seven; sides concave, the posterior and anterior margins decorated by nodular carinæ. A wide and regular suture separates the lower carina of one whorl from the upper carina of the next; the intercarinal spaces have no spiral ornamentation, but very fine axial lines may be seen on the glabrous surface.

The body-whorl is similar, but with a double nodulated carina round the base, which is flat and smooth, but rises towards the centre, where an umbilicus of moderate width and depth is girdled by a set of large tubercles, about eight in number. Aperture subrhomboidal and depressed.

Relations and Distribution.—This species is, perhaps, the most abundant Gasteropod in the Upper Division of the Inferior Oolite, being especially characteristic of the *Parkinsoni*-zone from Burton Bradstock as far north at least as Aston in the Cotteswolds. I have no specimens either from the Lincolnshire Limestone or from Yorkshire. It is essentially a Bajocian (*i. e.* Upper Division) form, being abundant at Bayeux, &c. French specimens seem to be rather wider-angled than ours. There is a marked variety from Powerstock in Dorset, which I have not figured.

This is very different to the polymorphous species usually known as *Trochus subduplicatus*, d'Orb., from the Lower Beds, but is closely related to the two forms next described.

311. Trochus angulatus, *Sowerby*, 1817. Plate XXXI, fig. 11.

1817. Trochus concavus, *Sowerby*. Min. Conch., pl. clxxxi, fig. 3; op. cit., vol. iv, index and corrigenda, 1823, as Trochus angulatus.
1854. — angulatus, *Sow.* Morris, Cat., p. 281.

This form is somewhat wider than average specimens of *T. duplicatus*, of which it may, to a certain extent, be considered a glabrous variety. Sowerby relied upon the presence of a few transverse striæ as helping to separate it. Though this test fails, the following important differences may be noted, viz. the extreme smoothness of the shell, the absence of umbilicus, and the fusion of the two keels into one.

Intermediate forms which show the connection, but which incline more towards *T. duplicatus*, occur in several places. Specimens, such as the one figured, are rare.

312. Trochus Duryanus, *d'Orbigny*, 1852. Plate XXXI, fig. 12.

1852. Trochus Duryanus, *d'Orbigny*. Terr. Jur., vol. ii, p. 280, pl. cccxiv, figs. 12—15.

Description:

Height	7 mm.
Width	6 mm.
Spiral angle	52°.

A single specimen from Grove (*Parkinsoni*-zone), having the above dimensions, so nearly accords with the description and figures of d'Orbigny that we seem fairly safe in making the identification.

This little shell has no umbilicus; otherwise it seems to vary from its near relative, *Trochus duplicatus*, in a direction precisely opposite to that of *Trochus angulatus*.

The *Subduplicatus*-group.

There is a varied series of trochiform shells in the Lower Division of the Inferior Oolite, mostly towards the Lias-boundary, which it is convenient to focus under "*Turbo*" *subduplicatus*, d'Orbigny, as the primary division, even if we indulge in varietal names.

313. Trochus subduplicatus, *d'Orbigny*, 1850. Plate XXXI, figs. 13 and 14.

1850. Turbo subduplicatus, *d'Orbigny*. Prod., 1, p. 248.
1852. — — — Terr. Jur., vol. ii, p. 339, pl. cccxxix, figs. 1—6 (notably figs. 4, 5, and 6).

Bibliography, &c.—When d'Orbigny, in the "Terrains Jurassiques," placed *Trochus duplicatus*, Sow., at the head of the synonymy of "*Turbo*" *subduplicatus*, d'Orb., that author appears to have forgotten that he had already (p. 275, pl. cccxiii, figs. 5—8) accepted Sowerby's species, which he described and figured with his usual fidelity. If anyone doubts the essential difference between *T. duplicatus*, Sow., and *T. subduplicatus*, d'Orb., let him refer to the figures and descriptions in d'Orbigny's own work. Moreover *T. duplicatus*, Sow., and *T. subduplicatus*, d'Orb., besides being very distinct in form, occur on quite different horizons.

Description.—There are two sizes; the dimensions given are those of the larger (fig. 14):

Height	16 mm.
Width	15 mm.
Spiral angle	68°.

Shell conical, not umbilicated; spire acute and about half the entire height. Number of whorls seven, slightly concave, distinctly separated by the suture, and provided with spinous carinæ on the posterior and anterior margins; there is no spiral ornamentation in the interspace, but in the younger and better preserved specimens a system of radial costæ connecting the spinous points may be noted. A fine system of growth-lines is associated with this ornamentation.

The body-whorl is large and sub-bicarinate; in the older shells the posterior row of spinous tubercles becomes indistinct towards the aperture, whilst the double carina is markedly spinous. The base is very full and puckered by a rugose system of axial costæ, which almost obliterate the fine spiral ornamentation noticeable in the younger shells; these costæ terminate in an irregular semicircle of large tubercles around a slight umbilical depression. Aperture subrhomboidal, the height and width being nearly equal, with a considerable callus on the rounded inner lip.

Relations and Distribution.—The chief point of resemblance in this species and *T. duplicatus* consists in a tendency to a duplex keel towards the basal periphery. *T. subduplicatus* is rugose, though wear and other causes may somewhat modify this peculiarity. There is also some variation in the size of the umbilical depression, though no true umbilicus exists; there is likewise considerable variation in other respects.

T. subduplicatus is probably better known as a fossil of the Upper Lias. Characteristic specimens, such as those figured, occur at Newton (Yeovil Sands) in the *Dumortieria*-beds. An extremely rugose variety, referred with some doubt to this species, was found in the *Variabilis*-beds of North Nibley.

Var. PLICATA, *Goldfuss*. Plate XXXII, fig. 2.

Turbo plicatus, Goldf., 'Petref. Germ.,' pl. 179, fig. 3. Cf. also d'Orbigny, 'Terr. Jur.,' vol. ii, pl. cccxxix, figs. 2 and 3, and Quenstedt, 'Der. Jura.,' p. 314, pl. xliii, fig. 19. Both d'Orbigny and Quenstedt agree that this form is only a variety of the preceding; the latter author observed that it is a somewhat simpler modification.

This modification consists chiefly in the fusion of the duplex carina of the

body-whorl into one thick nodular belt. In this form, also, the umbilicus is, for the most part, more completely closed, whilst the ornaments are softer in outline and less disposed to be spinous. Specimens are obtained from the lower part of the Yeovil Sands at Bridport Harbour in the *Dumortieria*-beds, and more rarely in the *Opalinus*-zone of Burton Cliff.

This tendency to fusion of the duplex carina is also noticeable in certain fine specimens of *T. duplicatus* from the *Parkinsoni*-zone of Powerstock, Broadwindsor, &c.

314. Trochus subduplicatus, var. Abbas. Plate XXXII, fig. 1.

Description:

Height	24 mm.
Width	21 mm.
Spiral angle	55°—60°.

Shell regularly conical, scarcely umbilicate; spire elevated, in most cases considerably exceeding half of the total height; apex sharp. Whorls seven to eight, very concave, and distinctly separated by a considerable suture. There is a nodular carina at the posterior and anterior margin of each whorl, the anterior one being usually compound; fine and regular spiral lines ornament the hollow portion of the whorls.

The body-whorl is much excavated and similarly ornamented, the nodular anterior carina being excessively thick and complex. The base is rather inclined to be flat, and is decorated with fine spiral lines throughout, which are more or less puckered by coarse radial lines converging towards the very slight umbilical fissure. Aperture subrhomboidal and slightly depressed, with a considerable callus on the inner lip.

Relations and Distribution.—In this very beautiful and highly ornamented shell we scarcely recognise our old acquaintance of the *Dumortieria*-beds. The intercarinal spaces, instead of being smooth, are full of spiral lines, which are also conspicuous in the base; the base likewise is flatter and the aperture more depressed. In the general figure there is some approach to *T. duplicatus*, but in no other respect.

Trochus Abbas is characteristic of the *Concavus*-bed at Bradford Abbas. I have one specimen from Burton Bradstock, horizon unknown. It may at once be distinguished from the *Dumortieria*-bed fossils by the fine spiral ornamentation in all stages, by its flatter base and larger habit of growth.

315. Trochus spiratus, *d'Archiac*, 1843, Inferior Oolite variety. Plate XXXI, figs. 6 and 7.

1843.	Trochus spiratus, *d'Archiac.*	Mém. Soc. Géol. France, vol. v, pt. 2, p. 378, pl. xxix, fig. 4.
1851.	— — —	Morris and Lycett, Great Ool. Moll., pt. 1, p. 106, pl. xiii, fig. 6.
1852.	— — —	d'Orbigny, Terr. Jur., vol. ii, p. 291, pl. cccxvii, figs. 16—19.
1853.	— — —	Morris, Q. J. G. S., vol. ix, p. 326.

Bibliography, &c.—D'Archiac refers to five or six spiral lines as occupying the flat part of the whorls. This species was first noticed in England by Morris and Lycett in the Great Oolite of Minchinhampton, and the same authors recognised it in the Lincolnshire Limestone of Ponton. *T. spiratus* seems not to be a fossil of the Anglo-Norman basin.

Description of the Lincolnshire Limestone variety:

Height	7 mm.
Width	6·5 mm.
Spiral angle	70°—76°.

The relations of width and height vary considerably. The shell is conical and not umbilicated. Spire elevated, but always less than half the total height, acute, but with a slightly flattened apex. Number of whorls five, the apical ones mostly plain, there being seldom any visible ornamentation above the penult, which is angular and possesses two principal and a small intermediate carina.

The body-whorl is relatively large and angular, and has five prominent spiral lines, of which the two principal, situate at the angle, cause it to be strongly bicarinate. The base is full and spirally striated. Aperture subrhomboidal with a slight tendency to a notch at the columellar extremity.

Relations and Distribution.—Specimens from Minchinhampton are more conical in outline, and the base is smooth instead of being spirally striated, as is also the case with specimens from Eparcy (Cossmann 'Ét. Bath.,' p. 298). In the Lincolnshire Limestone, specimens from Weldon show strong spiral lines in the base, whilst those from Ponton, on or about the same horizon, are smooth. Hence we might regard the Weldon fossil as a variety. Only found in the Upper Beds of the Lincolnshire Limestone, as far as the Inferior Oolite is concerned.

316. Trochus dimidiatus, *Sowerby*, 1817. Plate XXXI, fig. 8.

1817. Trochus dimidiatus, *Sowerby*. Min. Conch., pl. clxxxi, fig. 4.

Description :

Height	9 mm.
Width	9·5 mm.

Shell conical, smooth, without umbilicus. Spiral angle obtuse, from 70°—76°, spire rather less than half the total height. Number of whorls five, carinated above and below, concave between; sometimes the lower keel of the penult projects so as to produce a gibbous appearance.

Body-whorl large, angular, and bicarinated; base moderately full. Aperture subrhomboidal, with a tendency in some specimens to show a columellar furrow.

Relations and Distribution.—*Trochus dimidiatus* is variable as to size and shape, though rarely exceeding 10 mm. in height. In general outline it resembles *T. spiratus,* but has no spiral ornament beyond the very smooth keels.

It is principally a fossil of the Upper Division. A very depressed variety occurs rarely in the Dogger. A variety occurs at Weldon; small specimens at Hook Norton; typical forms in the *Parkinsoni*-zone of the Cotteswolds, also at Midford and at Dundry. Rather more elongated specimens occur in the *Parkinsoni*-zone of Grove, &c. There is a curious form in my Collection from Dundry.

As a possible variety of the above I draw attention to—

Trochus Zetes d'Orb., *fide* Tawney, Pl. XXXI, fig. 9.

1852. Trochus Zetes, *d'Orbigny*. Terr. Jur., vol. ii, p. 281, pl. cccxv, figs. 1—4.
1873. — — — Tawney, Dundry Gasteropoda, p. 32 (24), pl. ii, fig. 7.

We do not gather from the text of the "Dundry Gasteropoda," whether the specimen figured as *T. Zetes* came from Dundry or from Bradford Abbas. In the *Concavus*-bed at the latter place, *Trochus Zetes*, so-called apparently on Tawney's authority, occurs in considerable numbers (*vide* Fig. 9). The identification appears fairly correct; but the question naturally arises whether *Trochus Zetes* differs materially from *T. dimidiatus*. In the shells from Bradford Abbas the whorls of the spire are less angular, and there is a somewhat more marked umbilical excavation, the spire generally is less stumpy than in *T. dimidiatus.*

317. TROCHUS MONILITECTUS, *Phillips*, 1829. Plate XXXII, figs. 3 *a*, 3 *b*.

1829 and 1835.	TROCHUS MONILITECTUS, *Bean*, MS.		Phillips, Geol. Yorks., pt. 1, p. 152 (3rd edit., p. 259), pl. ix, fig. 33.
1850.	—	— *Phil.*	d'Orbigny, Prod., 1, p. 265.
1851.	—	— —	Morris and Lycett, Great Ool. Moll., pt. 1, p. 116, pl. xv, fig. 1.
1885.	—	— —	Hudleston, Geol. Mag., dec. 3, vol. ii, p. 121, pl. iii, figs. 1, 1 *a*, 1 *b*.
Cf. also	—	BRUTUS, *d'Orbigny*.	Terr. Jur., vol. ii, p. 283, pl. cccxv, figs. 13—16.
	—	— —	Cossmann, Étage Bath., p. 285, pl. vii, figs. 23—24.

Bibliography, &c.—This little shell is a genuine representative of the section *Zizyphinus,* and belongs to a group completely conical in outline, the result of flat whorls and a close suture. In the Bathonian of France *Trochus Zenobius*, d'Orb., seems to represent it. *Trochus Brutus*, which has a wider spiral angle, is stated by M. Cossmann, on the authority of Schlumberger, to be common in the Bajocian, I presume of eastern France.

Description.—Typical form from the Scarborough Limestone of Cloughton Wyke :

Height	8 mm.
Width	7·5 mm.
Spiral angle	60°.

Shell regularly conical, imperforate ; spire acute, and nearly two-thirds the total height. Whorls flat, suture extremely close. The ornaments consist of four, and sometimes five equal spiral bands, which are close together and evenly tuberculated, the tubercles or granules being nearly circular.

The body-whorl has four tuberculated spirals, together with a thicker belt, constituting the basal periphery. Base flat with faint spiral striæ towards the margin (not always visible), the rest smooth or only marked by faint radial lines. Aperture rhomboidal and depressed.

Relations and Distribution.—The typical *T. monilitectus* seems almost confined to the Scarborough Limestone and to the Upper Beds of the Lincolnshire Limestone, especially at Ponton, where its presence was first recorded by Morris in 1853 ('Quart. Journ. Geol. Soc.,' vol. ix, p. 326).

Further south, *e. g.* in the *Parkinsoni*-zone of Aston, Notgrove, and Horton Hill, and also at Grove, near Castle Cary in Somersetshire, there occurs a larger form with five or six nodular spirals (see fig. 4). The greater number of spirals is often

associated with a slight basal carina which breaks the uniformity of the cone, and thus we gradually pass to another species. In my own Collection these are marked var. "*nemoralis*." It is quite possible that they are undeveloped forms of *Trochus substrigosus*, described below. For similar forms see 'Geol. Mag.' vol. *cit.*, pl. iii.

318. Trochus subluciensis, sp. nov. Plate XXXII, figs. 6 and 7.

Description (full size):

Height	14 mm.
Width	10 mm.
Spiral angle	40°—45°.

Shell regularly conical, not umbilicate. Spire acute, about two-thirds the total height. Number of whorls about seven, perfectly flat, and increasing with complete regularity; sutures close. The ornaments consist of four thick, tuberculated spirals, each tubercle presenting a squamous appearance, owing to a crescent-shaped hollow on the anterior side.

In the body-whorl the number of these squamous spirals increases to five and even more; the anterior spiral is usually deflected away from the base, which is flat and without ornament. Aperture rhomboidal and much depressed.

Relations and Distribution.—It is extremely probable that there is more than one species amongst these narrow-angled and squamously-ornamented shells, but the state of preservation is scarcely favorable for close discrimination. The spiral angle accords with that of *Trochus Luciensis*, d'Orb.; but in that species the spirals are simply nodular, and do not appear to assume the peculiar rope-like character, which enables one to recognise even a fragment of *Trochus subluciensis.*

These shells are characteristic of the *Murchisonæ*-zone, occurring in the Oolite Marl of Nailsworth, and in the *Murchisonæ*-zone at Stoford and Bradford Abbas; also on the same horizon in the Irony Nodule-bed at Burton Bradstock.

A modified form is found in the "Base-bed" at Lincoln, which is also in the *Murchisonæ*-zone. With reference to the Gasteropoda in this bed, it may be observed that their tendency to vary in the direction of bizarre forms is noteworthy. Whether *Trochus squamosior*, next described, is a species or a "sport" must be left an open question.

319. TROCHUS SQUAMOSIOR, sp. nov. Plate XXXII, fig. 5.

Description :

Height	9 mm.
Width	9 mm.
Spiral angle	65°.

Shell conical, not umbilicate; spiral angle slightly concave. Spire acute, sutures close. Number of whorls seven, flat, those at the apex without ornament; the three succeeding whorls carry from two to three tuberculated and subsquamose spirals. The penult has four spirals, of which the third is the least prominent.

The body-whorl has five spirals, of which the middle one is the weakest. All the spirals of the anterior whorls are armed with hollow spinous projections, the hollow inclining to the anterior side; the last spiral, constituting the basal periphery, is turned backwards. Base flat and smooth. Aperture rhomboidal and depressed.

Relations and Distribution.—Although possibly only a sport of the local representative of *T. subluciensis*, yet the wider spiral angle and tendency to a concave spire are indications which may be relied on, even when the exceptional preservation of the spines, exhibited in the figured specimen, is wanting.

Rare in the "Base-bed" at Lincoln. I have seen something like this form on a small scale in Mr. Walford's Collection from Hook Norton.

320. TROCHUS SQUAMIGER, *Morris and Lycett*, 1851, Inferior Oolite variety. Plate XXXII, fig. 8.

1851. TROCHUS SQUAMIGER, *Morris and Lycett.* Great Ool. Moll., pt. 1, p. 62, pl. ix, fig. 34; pl. xiii, fig. 7.

Description :

Height	6·3 mm.
Width	7 mm.
Spiral angle	68°.

Shell regularly conical, imperforate. Spire elevated and acute, though the actual apex is slightly obtuse. Number of whorls six, perfectly flat and increasing regularly; sutures close. The ornaments consist of spiral bands distinguished by nodules which are squamosely tubular and excavated on the anterior side. On the

body-whorl these spirals are four in number. Base flat, with a crenulated margin and delicate spiral ornamentation (rarely preserved).

Relations and Distribution.—The Inferior Oolite variety is more perfectly conical and wider than the Minchinhampton one. Obviously related to *T. squamosior*, this species never exhibits the deflected basal periphery.

Rare in the Oolite Marl horizon near Nailsworth.

321. Trochus vicinus, sp. nov. Plate XXXII, fig. 9.

Description :

Height	8 mm.
Width	7 mm.
Spiral angle	57°.

Shell regularly conical, imperforate. Spire acute and nearly two-thirds of the total height. Number of whorls seven, flat; those near the apex probably plain; sutures distinct. Anterior whorls of the spire ornamented with four granular spirals, the posterior of which contains the strongest nodulations.

In the body-whorl the first and third spirals contain the largest nodulations; the fourth spiral is often split, and the basal periphery is prominent. Base moderately flat and smooth. Aperture subquadrate with a columellar furrow.

Relations and Distribution.—In spiral angle and general outline this species greatly resembles *T. monilitectus*, from which it is chiefly distinguished by its more varied spiral ornamentation, and by a fuller base and less depressed aperture. I have not been able actually to identify this form with any from the Lower Oolites of the east of France, although it seems to run into forms not very unlike *Trochus Bellona*, d'Orb.

Common in the Lincolnshire Limestone at Weldon, where the varieties are numerous; occasionally met with in the *Parkinsoni*-zone of the Cotteswolds.

322. Trochus Dunkeri, *Morris and Lycett*, 1851, var. *Weldonis*. Plate XXXII, fig. 10.

1851. Trochus Dunkeri, *Morris and Lycett.* Great Ool. Moll., pt. 1, p. 61, pl. x, fig. 3.

Description :

Height and width about . . .	7 mm.
Spiral angle	57°.

Shell regularly conical, imperforate. Spire acute and about two-thirds the total height. Number of whorls seven, flat or very slightly concave, sutures distinct; apical whorls smooth; in the later whorls a fine unornamented spiral belt bounds the anterior margin of each whorl; sinuous growth lines are conspicuous throughout. In the body-whorl these lines start from a granular spiral belt, situate at the posterior margin, and extend to the basal angle, which is sharply defined. Base rather flat and smooth; aperture subquadrate.

Relations and Distribution.—The Weldon fossil differs from *T. Dunkeri*, of the Great Oolite, in the plain anterior belt at the base of each whorl, in this respect resembling *Trochus Actæa*, d'Orb. But other considerations prevent us from regarding it as identical with d'Orbigny's species. This is undoubtedly very near to *T. Dunkeri*, but even the rolling to which the Minchinhampton shells have been subject could scarcely have obliterated the belt entirely. The other differences might be fairly accounted for by difference of matrix.

There are many varieties of *Trochus Weldonis*, connecting with other forms. Common in the Lincolnshire Limestone at Weldon.

323. Trochus substrigosus, sp. nov. Plate XXXII, fig. 11, and ? fig. 4 (incomplete).

But cf. Trochus acanthus, *d'Orbigny.* Terr. Jur., vol. ii, p. 273, pl. cccxii, figs. 9—12.
— strigosus, *Lycett.* Suppl., p. 29, pl. xlv, fig. 12.
— acanthus, *d'Orb.* Cossmann, Ét. Bath., p. 286, pl. x, figs. 27, 28.

N.B.—Although *T. acanthus*, d'Orb., is a fossil of Port-en-Bessin, and consequently belonging to the true Bajocian or Upper Division of the Inferior Oolite, our fossils differ so much from d'Orbigny's figures that I scarcely dare venture on absolute identification. On the other hand, there is a considerable resemblance between our fossils and *T. strigosus*, Lycett, from the Yorkshire Cornbrash. Now M. Cossmann, *loc. cit.*, observes that, even supposing *T. strigosus* is not an actual synonym of *T. acanthus*, the name is pre-occupied. The only way out of these difficulties is to make a new species.

Description (complete specimen):

Height	23 mm.
Width	21 mm.
Spiral angle	60°.

Shell conical, imperforate; spiral angle tolerably regular. Spire rather more than half the total height and acute. The total number of whorls is about eight; those of the spire (except close to the apex) are flat to very slightly concave, with

a rather close suture in the early stage, which becomes wider; six or seven fine granular spirals ornament the whorls of the spire, the posterior and anterior spiral being slightly the most prominent in some cases, so as to form slight belts in the neighbourhood of the suture.

In the body-whorl, which is rather tumid, the ornaments become irregular with a tendency to effacement of the spiral lines, but there is often a marked bicarination at the angle of the shell; the angle is rounded off into a full base, which is marked by fine wavy spiral striæ. Growth-lines decussate the general ornamentation and are very conspicuous where the spiral lines fail. Aperture subquadrate with some thickening of the inner lip.

Relations and Distribution.—*Trochus substrigosus* is a truly polymorphous shell, and when, it develops an additional whorl, we have some difficulty in believing that the species is the same—in other words, that fig. 4 and fig. 11 are different conditions of the same species.

The more perfect form (fig. 11) occurs sparingly in the *Parkinsoni*-zone of Bradford Abbas and Burton Bradstock. Fossils from the Cornbrash of Scarborough exhibit a similar polymorphous tendency.

324. Trochus Burtonensis, *Lycett*, 1863, Inferior Oolite variety. Plate XXXII, fig. 12.

1863. Trochus Burtonensis, *Lycett.* Suppl., p. 99, pl. xlv, fig. 16.

Description :

Height	13 mm.
Width	13 mm.
Spiral angle	60°.

Shell regularly conical, imperforate. Spire elevated, acute; sutures close. Number of whorls seven, flat and without ornament. Sometimes one of the whorls overhangs a little, otherwise there is hardly any break in the outline of a perfect cone. There is a slight keel at the base of the body-whorl. Base nearly flat and smooth. Aperture subrhomboidal and depressed, with a considerable columellar callus.

Relations and Distribution.—One would imagine that there should not be much difficulty in finding a name for this perfectly smooth and regularly conical shell. *Trochus Halesus*, d'Orb., presents some features of resemblance, but M. Cossmann regards that species as an *Ataphrus* rather than a *Trochus*. Again *Trochus Actæa*, d'Orb., has a resemblance, yet we miss the "bourrelet" characteristic of that species. The Inferior Oolite fossil figured in the accompanying plate differs from

Trochus Burtonensis, Lyc., in the greater flatness of the base and the sharper angles of the basal periphery. Yet some of our Inferior Oolite specimens are scarcely distinguishable from real Bradford Clay fossils. As a mere collection name I suggest var. "*Hortonensis*."

I notice this form from the Inferior Oolite of the Hook Norton district. In the Cotteswolds it is chiefly confined to the *Parkinsoni*-zone and is especially abundant at Horton Hill.

325. ? Trochus Leckenbyi, *Morris* and *Lycett*, 1851. Plate XXXII, fig. 13.

1851. ? Trochus Leckenbyi, *Morris and Lycett*. Great Ool. Moll., pt. 1, p. 115, pl. xv, fig. 21.
1885. — — — Hudleston, Geol. Mag., dec. 3, vol. ii, p. 126, pl. iii, fig. 7.

Bibliography, &c.—The authors appeared to have had a suspicion that this was a *Pleurotomaria*, although nothing upon the surface of the whorls indicated that such was the case.

Description :

Height	15 mm.
Width	17 mm.
Spiral angle	85°.

Shell conical, imperforate. Spire regular and about half the entire height. Number of whorls five, nearly flat; suture rather close. The ornaments consist of stout granulated spiral bands, those towards the base of each whorl having a slight prominence.

The body-whorl shows a slight prominence at the basal periphery. Base nearly flat, with strong spirals decussated by radiating lines. Aperture trapezoidal and depressed.

Relations and Distribution.—Probably a *Pleurotomaria* with the *sinus*-band obscured. A single specimen from the Scarborough Limestone.

326. Trochus biarmatus, *Münster*, 1844. Plate XXXII, fig. 14.

1844. Trochus biarmatus, *M.* Goldf., Petref. Germ., pl. clxxx, fig. 2.
1873. Littorina biarmata, *M.* Tawney, Dundry Gasteropoda, p. 24 (16).
Cf. also Trochus bitorquatus, *Héb. and Desl.* Foss. Montreuil-Bellay, p. 61, pl. ii, fig. 6.

Bibliography, &c.—According to Tawney (*op. cit.*), Oppel, and after him Brauns, identified Münster's species with *T. monilitectus*, Phil., but for this identification there is clearly no warrant. I cannot follow Tawney in regarding this species as a *Littorina*.

Description :

Height	12·5 mm.
Width	10·5 mm.
Spiral angle	52°.

Shell conical, not umbilicated, slightly turreted. Spire nearly two-thirds the total height; spiral angle sometimes rather obtuse. Number of whorls seven, separated by a very wide suture. Those at the extreme apex are smooth, but all the principal whorls are concave, and bounded by tuberculated spiral belts at the posterior and anterior margins.

The body-whorl, which is separated from the spire by a very wide suture, is similar in shape and ornament, but carries a third keel at the angle of the shells, the third one being the least prominent. Base nearly flat and spirally ornamented. Aperture subrhomboidal and depressed.

Relations and Distribution.—Regarded as a *Trochus* this species stands pretty well alone. *T. biarmatus*, M., differs from English specimens in having the third keel exposed in the whorls of the spire—always supposing the enlarged figure of Goldfuss to be an accurate representation. *Trochus bitorquatus*, Héb. and Desl., greatly resembles our Inferior Oolite specimens.

Trochus biarmatus with us is essentially a fossil of the *Parkinsoni*-zone or of the beds immediately below. The most northerly point noted is Notgrove. At Horton Hill it is abundant and well developed. The best specimens come from Grove and Woolston (Castle Cary district). It is met with in the *Parkinsoni*-marl of Bradford Abbas; also at Stoford, and in the *Parkinsoni*-zone of South Dorset.

327. Trochus marga, sp. nov. Plate XXXII, fig. 15.

Description :

Height	6 mm.
Width	5 mm.
Spiral angle	52°.

Shell conical, imperforate. Spire elevated and acute with a slightly obtuse apex. Number of whorls six; slightly concave, with a considerable anterior prominence. Body-whorl very concave with a blunt carina at the angle. The entire shell is ornamented by fine spiral striæ, closely set, and faintly decussated

by axial lines. Base rounded and similarly ornamented. Aperture subquadrate with a columellar furrow.

Relations and Distribution.—An increase in the strength of the axial ornamentation would approximate this form to *Trochus Niortensis.*

T. marga is most abundant in the *Parkinsoni*-marl at Bradford Abbas. It occurs more rarely on the same horizon at Burton Bradstock.

328. TROCHUS NIORTENSIS, *d'Orbigny*, 1852.

1852. TROCHUS NIORTENSIS, *d'Orbigny.* Terr. Jur., vol. ii, p. 282, pl. cccxv, figs. 5—8.
1873. — — — Tawney, Dundry Gasteropoda, p. 33 (25).

When Mr. Tawney wrote, there were in the Bristol Museum two specimens from Dundry agreeing precisely with d'Orbigny's description. A third specimen has since been added. Mr. Wilson, the present curator, informs me that this species ranges up from the Middle Lias. The micromorph from the Pea-grit of Leckhampton (Pl. XXXII, figs. 18 *a*, 18 *b*) is related. N.B.—The whorls of this small shell are more concave than is shown in the enlargement.

329. TROCHUS, species or variety. Plate XXXII, fig. 16.

A small, unornamented *Trochus*, with whorls very much undercut, occurs sparingly at Weldon in the Lincolnshire Limestone. In my Collection this is designated *Trochus* "*subimbricatus*."

330. TROCHUS cf. BIXA, *d'Orbigny*, 1850. Plate XXXII, fig. 17; and ? Plate XXXI, fig. 16.

1850. TROCHUS BIXA, *d'Orbigny.* Prod., 1, p. 300.
1852. — — — Terr. Jur., vol. ii, p. 287, pl. cccxvi, figs. 13—16.
Cf. also — LANGRUNENSIS, *d'Orb.* Cossmann, Étage Bath., p. 289, pl. xiii, figs. 24—25.

Bibliography, &c.—Specimens from our Inferior Oolite agree so well with the description and figures of d'Orbigny of a shell from the Bathonian of Luc in Calvados that I do not feel justified in separating them, notwithstanding the difference in geological age. M. Cossmann regards *T. Bixa*, d'Orb., as merely a synonym of *T. Langrunensis*, d'Orb.; but as our shells resemble *T. Bixa* I retain the former name, the more so since the essential feature of spiral striation is entirely wanting in *T. Langrunensis*—possibly from attrition.

Description :

Height	8 mm.
Width	6 mm.
Spiral angle (about)	60°.

Shell conoidal, imperforate; spiral angle obtuse with a rather sharp apex. Number of whorls about five, moderately convex, sutures close; the ornaments consist of very numerous, fine, spiral lines, with but faint traces of radial decussation. The body-whorl is about half the entire height, and slightly compressed anteriorly so as to be well within the spiral angle. The spiral lines are extremely numerous, and one, a little more elevated than the rest, forms a slight keel at the angle of the whorl; this angle is rounded off into the very full base, which is similarly striated. The aperture is suborbicular and rather restricted, without the least trace of an umbilical or columellar furrow.

Specimens from Lincoln are similar, except that the base is rather more rounded off and there is a slight "monodontoid" appearance on the columel a.

Relations and Distribution.—This peculiar form seems to stand by itself in our Inferior Oolite, occurring in the *Murchisonæ*-zone at two widely separate localities, viz. at Lincoln in the "Base-bed," and at Burton Bradstock in the Irony Nodule-bed.

331. ? TROCHUS BICINGENDUS, *Lycett*, 1850. Plate XXXI, fig. 15.

1850. TROCHUS BICINGENDUS, *Lycett.* Ann. Mag. Nat. Hist., 2nd ser., vol. vi, p. 416; and Proc. Cotteswold Nat. Club, vol. i, p. 77.

The following is the author's diagnosis:—"Elevated whorls rather concave, with two encircling nodose ribs, one at each margin of the whorl, and three mesial circles of nodules."

The type, which is in the Jermyn-Street Museum, measures:—Height 8 mm., width 4·5 mm., spiral angle 45°. From the Inferior Oolite of the Cotteswolds.

It seems probable that *Trochus bicingendus* represents the early stage of a shell from the Pea-grit of Longfords, represented in the present work (Pl. XXIV, fig. 7), and which was correlated (p. 301) with *Littorina recteplanata*, Tawney. If this correlation be correct, it would seem proper to substitute Lycett's specific name; but, since there is a doubt, we must retain both names for the present.

It is quite likely that I have not succeeded in enumerating every species of fossil shell from our Inferior Oolite entitled to the name of *Trochus*. For instance, there is *T. clypeatus*, Witchell ('Proc. Cotteswold Nat. Club,' vol. vii, p. 128, pl. iv, fig. 3), which I have not seen; though, to judge from the figure and description, it is most probably identical with *Trochus dimidiatus*, Sow.

On the other hand, there occurs in the *Concavus*-bed at Bradford Abbas a remarkable trochoid species, which, although it is probably not a *Trochus*, I may enumerate provisionally under this genus.

332. "TROCHUS" ATTROCHUS, sp. nov. Plate XXIX, fig. 15, and var. fig. 16.

Description :

Height	5·5 mm.
Width	6 mm.

Shell irregularly conical, thin, subumbilicate. The angle of the spire is regular, but owing to the sudden increase of the body-whorl, the spiral angle of the entire shell is concave. In fact, so ventricose is the body-whorl that, in some cases, the spire has the appearance of belonging to another shell. Total number of whorls five; those of the spire are flat (smooth at the extreme apex), whilst the penult and antepenult are ornamented with a loosely granulated spiral on the posterior margin, and a finely granulated keel anteriorly.

The body-whorl is angular and enormously ventricose, and separated from the spire by a wide and subcanaliculate suture. The ornaments are the same as in the lower whorls of the spire, viz. a circlet of distant nodules on the posterior edge, and a conspicuous carina with fine granulations; this carina is median, and above it there are no certain traces of spiral lines, whilst below and in the base are considerable indications of spiral lines. Base widely but not deeply excavated. The aperture is large and prominent anteriorly, the lips being somewhat thin, outer lip angular, inner lip circular. N.B.—The thickening of the inner lip, shown in Fig. 15, is not quite correct.

Varieties.—There is considerable irregularity of development. In some specimens the whorls of the spire appear undercut owing to the salience of the the carina; in these cases the body-whorl is usually less ventricose, and the shell more regularly conical. The variety from Beaminster (fig. 16), besides being smaller, shows some modification in the spiral ornament below the carina of the body-whorl, and otherwise differs in some minor points.

Relations and Distribution.—At present this curious species seem to stand alone with reference to the other Gasteropoda of the Inferior Oolite. It may be related to some of the perforated *Trochi* of the Paléontologie Française; but Gemmellaro's genus *Palæoniso*, if one may judge from the species described and figured by that author, does not seem applicable in the present instance.

Known only from the *Concavus*-bed at Bradford Abbas and the parallel horizon at Beaminster.

PLATE XXVII.

N.B.—*About half the figures are drawn from photographs, more or less enlarged.*

FIG.

1 *a*, 1 *b*. *Onustus pyramidatus*, Phillips. Wide-angled variety with straight ribs. From (?) *Murchisonæ*-zone, Chideock. My Collection. Front and base × $1\frac{1}{2}$. (Page 326.)

2 *a*, 2 *b*. The same. Specimen believed to be the type, Dogger; Blue Wyke. York Museum. Back and base × $1\frac{1}{2}$.

3. *Onustus acuminatus*, sp. nov. *Murchisonæ*-zone, North Dorset. Whidborne Collection. Back × $1\frac{1}{2}$. (Page 328.)

4 *a*, 4 *b*. *Onustus heliacus*, d'Orb., var. *opalina*. *Opalinus*-zone, Drympton. My Collection. Front and base × $1\frac{1}{2}$. (Page 329.)

5 *a*, 5 *b*. *Onustus* cf. *lamellosus*, d'Orbigny. (The base shows a deeply excavated umbilicus as in d'Orbigny's figure, but the radial ornaments are wanting). *Concavus*-bed, Bradford Abbas. My Collection. Front and base × $1\frac{1}{2}$. (Page 328.)

6 *a*, 6 *b*. *Onustus Heberti*, Laube. Stoford. ? *Parkinsoni*-zone. My Collection. Front and base × 2. (Page 329.)

7. The same. Wide-angled variety, with the spirals in the base and the crenulations of the margin more strongly developed. *Cadomensis*-bed, Oborne. My Collection. Base × 2.

8 *a*, 8 *b*. *Onustus ornatissimus*, d'Orbigny. *Parkinsoni*-zone, Burton Bradstock. My Collection. Front and base × $1\frac{1}{2}$. (Page 330.)

9 *a*, 9 *b*, 9 *c*. *Neritopsis Bajocensis*, d'Orbigny. *Parkisoni*-zone, Burton Bradstock. My Collection (Stephens). Front, back, and apex × $1\frac{1}{2}$. (Page 340.)

10. Operculum of *Neritopsis Bajocensis*, d'Orb. *Humphriesianus*-zone, Sherborne district. My Collection (Stephens). In position, natural size.

11 *a*, 11 *b*, 11 *c*. *Neritopsis Philea*, d'Orbigny, Inferior Oolite variety. *Concavus*-bed, Bradford Abbas. My Collection. Front, back, and apex × $1\frac{1}{2}$. (Page 341.)

PLATE XXVII

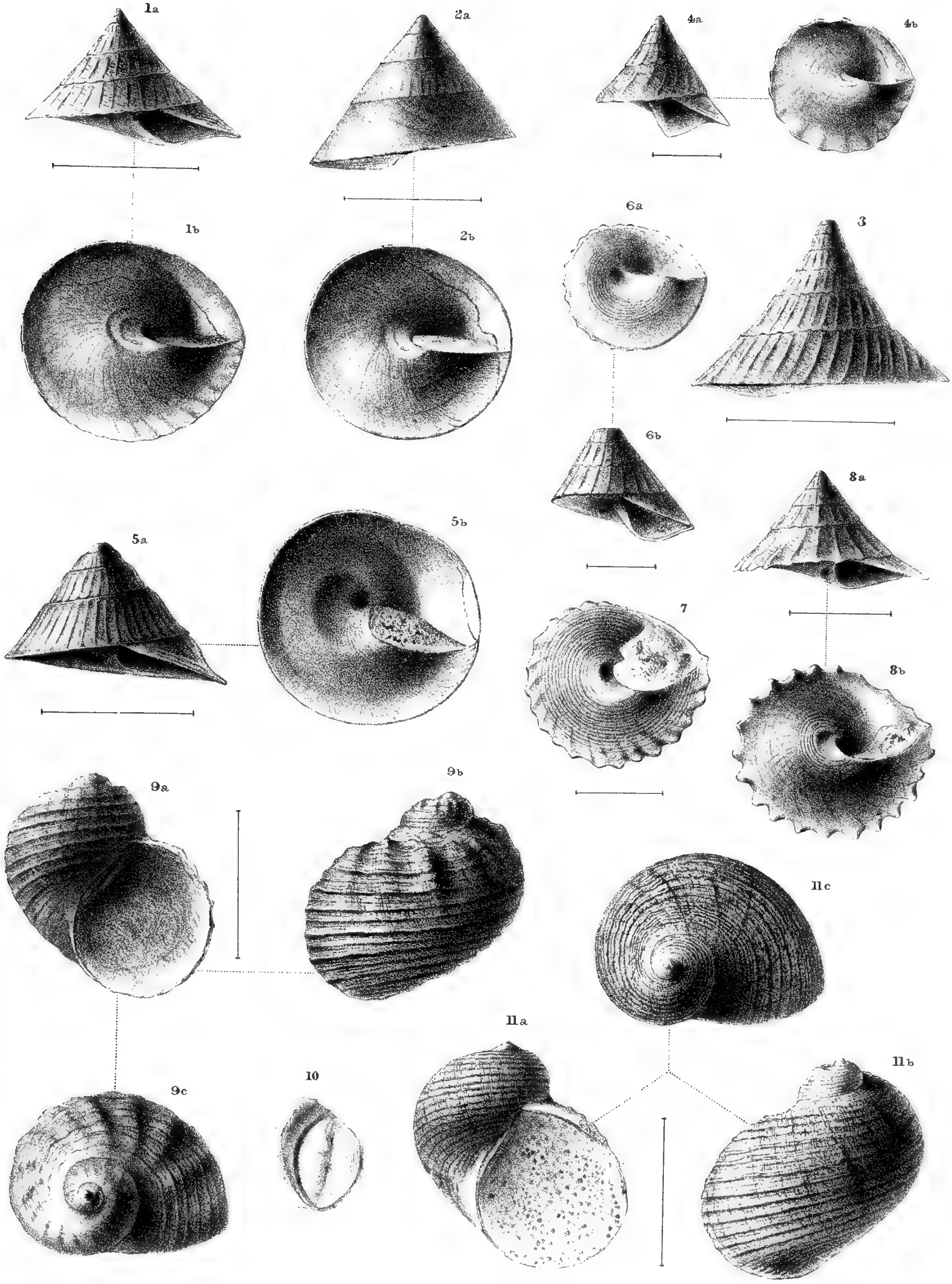

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PLATE XXVIII.

N.B.—*All figures, except figs.* 16, 17 *b*, *and* 18 *b*, *are from pencil drawings.*

FIG.

1 *a*, 1 *b*, 1 *c*. *Neritopsis varicosa*, Morris and Lycett. Oolite Marl, Nailsworth. My Collection (Wright). Front, back, and apical × 2. (Page 341.)

2. *Neritopsis incisa*, sp. nov. Base of Lincolnshire Limestone, Swan's Brickyard, Lincoln. My Collection. Back × 2. (Page 342.)

3 *a*, 3 *b*, 3 *c*. *Neritopsis* cf. *Hebertana*, d'Orbigny. Stoford. My Collection. Back, front, and apical × 2. (Page 343.)

4. *Neritopsis* cf. *sulcosa*, d'Archiac, or ? a modified form of *N. Philea*, d'Orb. Pea-grit, Crickley. My Collection. Back × 2. (Page 344.)

5 *a*, 5 *b*, 5 *c*. *Neritopsis* cf. *decussata*, Münster. Base-bed, Lincoln. Back, front, and apical × 2. (Page 342.)

6 *a*, 6 *b*. *Nerita costulata*, Deshayes (*Nerita costata*, Sow.). Variety from the Scarborough Limestone, White Nab. Herries Collection. Back and apical × 2. (Page 332.)

7, 8, 9. *Nerita pseudocostata*, d'Orbigny. Dogger, Blue Wyke. Leckenby Collection. Three specimens showing different aspects, each × 2. (Page 333.)

10. "*Neritopsis lævigata.*" Dogger, Blue Wyke. Jermyn Street Museum. Front × 2. (Page 344.)

11 *a*, 11 *b*. *Nerita* (*Neridomus*) near to *ovata*, Römer (cf. also *Neritina Cooksonii*, Deslongchamps). Pea-grit, Crickley. My Collection. Front and back × 2. 11 *c*. Portion further enlarged to show colour markings. (Page 336.)

12 *a*, 12 *b*. *Nerita* (*Neridomus*) *tumidula*, Phillips. Dogger, Blue Wyke. My Collection. Front and back × 2. (Page 335.)

13 *a*, 13 *b*. *Pileolus plicatus*, Sowerby, var. A. Base-bed, Lincoln. My Collection. Apical and side × 3. (Page 337.)

14 *a*, 14 *b*, 14 *c*. *Pileolus plicatus*, Sow., var. B. Same locality and Collection. Apical, side and base × 3. (Page 337.)

15 *a*, 15 *b*, 15 *c*. *Pileolus lævis*, Sowerby. Inferior Oolite variety. Same locality and Collection. Apical, side and base × 3. (Page 338.)

16. Section of *Pileolus* to show the columellar septum. Base of Lincolnshire Limestone, Lincoln. My Collection. Section × 3. (Page 337.)

17 *a*, 17 *b*. *Crossostoma* cf. *Prattii*, Morris and Lycett. ? Irony Nodule-bed, Burton Bradstock. My Collection. Front and back × $1\frac{3}{4}$. (Page 346.)

18 *a*, 18 *b*. *Ataphrus* cf. *lucidus*, Thorent. Freestones of the Oolite Marl horizon, Nailsworth Hill. My Collection. Front and back × $1\frac{3}{4}$. (Page 348.)

PLATE XXVIII

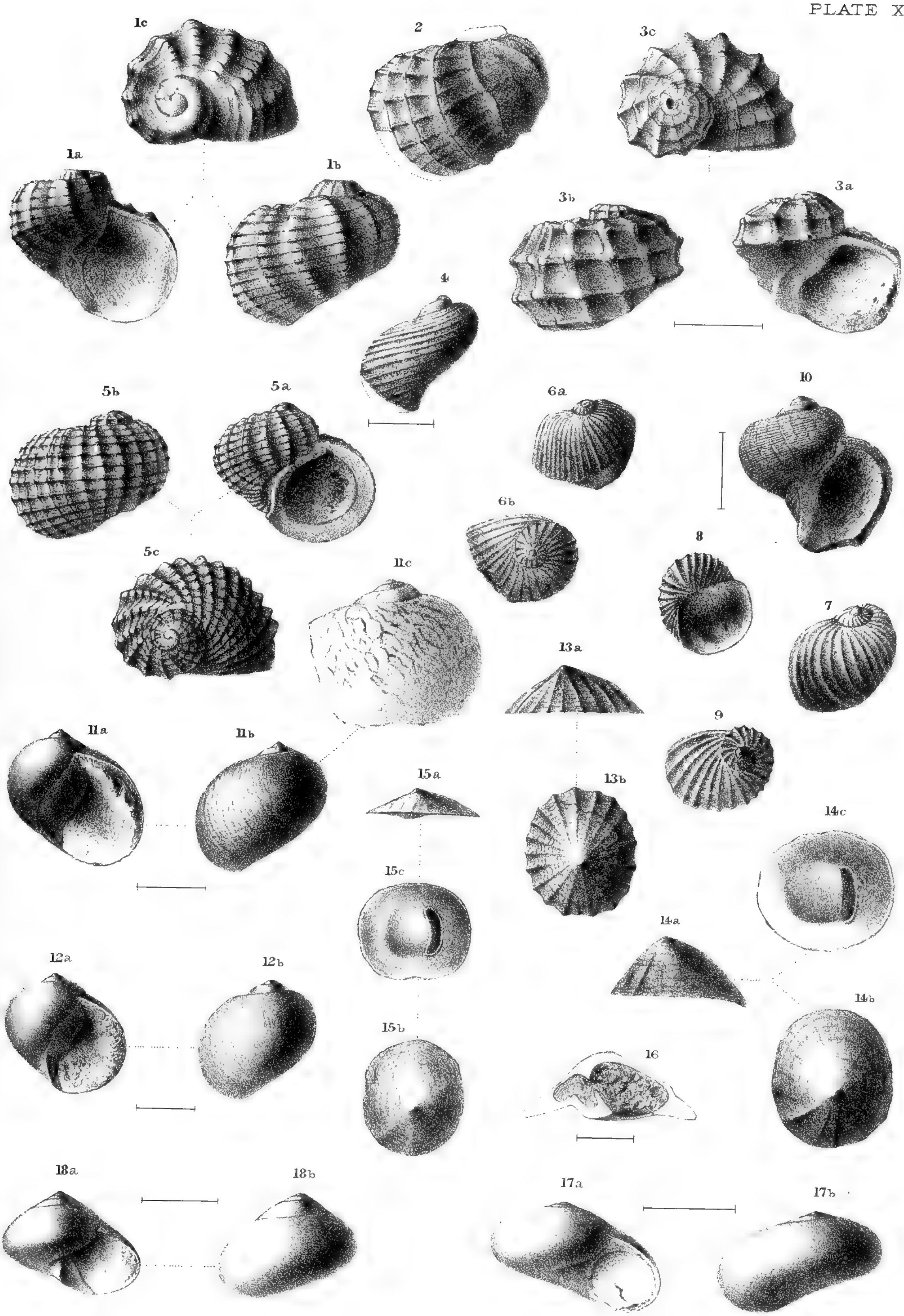

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PLATE XXIX.

N.B. 1. *About half the figures are drawn from photographs, more or less enlarged.*
N.B. 2. *All specimens are from my Collection unless otherwise stated.*

Fig.

1. *? Turbo lævigatus*, Phillips. Lincolnshire Limestone, Weldon. Front and back × $2\frac{1}{2}$. (Page 354.)
2. *Turbo "paludinoides."* *Concavus*-bed, Bradford Abbas. Back and front. (Page 355.)
3. *Turbo (? Ataphrus) Lindecolinus*, sp. nov. Base of Lincolnshire Limestone, Lincoln. Front × $2\frac{1}{2}$. (Page 355.)
4. The same (another specimen). Same horizon and locality. Back × $2\frac{1}{2}$.
5. *Ataphrus lævigatus*, Sowerby. *Concavus*-bed, Bradford Abbas. Front and back × $1\frac{3}{4}$. (Page 349.)
6. The same; variety approaching *Ataphrus Belus*, d'Orb. Lincolnshire Limestone, Weldon. Front and back × $1\frac{3}{4}$.
7. *Ataphrus obtortus*, sp. nov. Inferior Oolite, Beaminster. Front and back × $1\frac{3}{4}$. (Page 350.)
8. The same. Burton Bradstock, horizon unknown. Back and front × $1\frac{3}{4}$.
9. *Ataphrus Labadyei*, d'Archiac. Bradford Abbas, ? *Concavus*-bed. Front and back × $1\frac{3}{4}$. (Page 350.)
10. The same; wider-angled variety. Pea-grit, Holcomb. Front and back × $1\frac{3}{4}$.
11. *Ataphrus Acmon*, d'Orbigny; wide-angled variety. *Parkinsoni*-zone, Burton Bradstock. Front and back × $1\frac{3}{4}$. (Page 351.)
12. The same; Neritoid variety. *Parkisoni*-zone, Burton Bradstock. Front and back × $1\frac{3}{4}$.
13. The same; variety from Hook Norton, approaching *Monodonta papilla*, Héb. and Desl. Front × 2.
14. *Ataphrus Acis*, d'Orbigny (*? Trochus Ibbetsoni*, Morris and Lycett). Burton Bradstock, probably from the *Parkinsoni*-zone. × $1\frac{3}{4}$. (Page 352.)
15. "*Trochus*" *attrochus*, sp. nov. *Concavus*-bed, Bradford Abbas. Front × $4\frac{1}{2}$. (Page 390.)
16. The same; variety from Beaminster. Front × $4\frac{1}{2}$.
17. *Monodonta pisolitica*, sp. nov. Pea-grit, Leckhampton. Front and back × $2\frac{1}{2}$. (Page 356.)
18. ? The same; specimen modified by age. Same horizon and locality. Front and back × $2\frac{1}{2}$.
19. *Turbo Hamptonensis*, Morris and Lycett. Bradford Abbas. Back × $2\frac{1}{2}$. (Page 359.)
20. The same. Inferior Oolite, Hook Norton. Front × $2\frac{1}{2}$.

PLATE XXIX

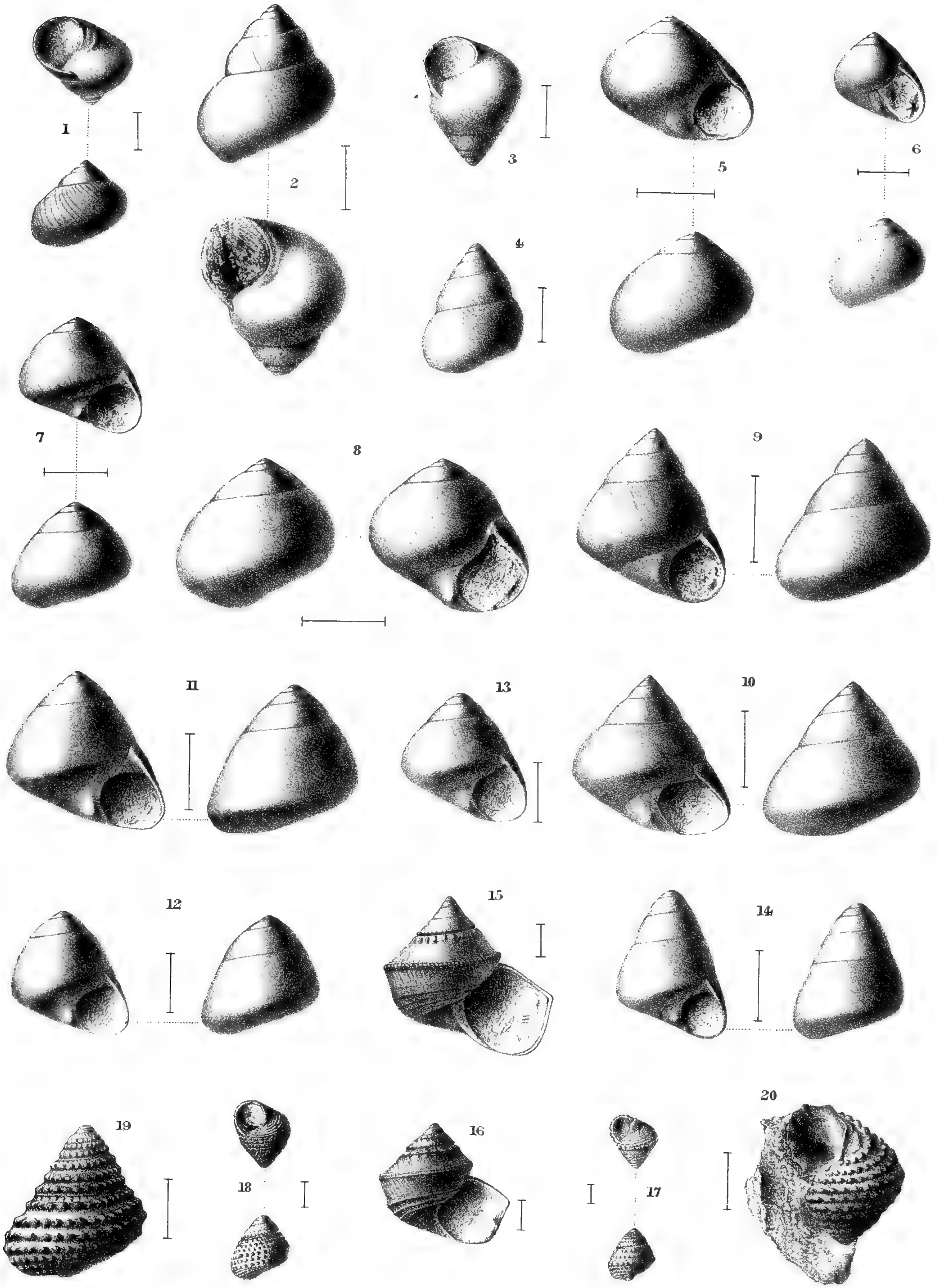

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PLATE XXX.

N.B. 1. *All the figures on this plate are drawn from photographs.*

N.B. 2. *All specimens are from my Collection unless otherwise stated.*

N.B. 3. *All figures magnified about two diameters.*

Fig.

1. *Monodonta Lyelli*, d'Archiac. Lincolnshire Limestone, Weldon. Back and front (Page 357.)
2. The same; variety with shorter spire. Same horizon and locality. Back.
3. *Monodonta Lyelli*, var. *humilis*. Lincolnshire Limestone, Ponton or Barnack. British Museum. Back and front.
4. *Turbo* "*depressiuscula*." Lincolnshire Limestone. Same Collection. Back. (Page 358.)
5. *Turbo* "*spathica*" (cf. *T. delphinuloides*, d'Archiac). Lincolnshire Limestone. Same Collection. Back and front. (Page 359.)
6. *Turbo Davoustii*, d'Orbigny, var. *Lindonensis*. Base of Lincolnshire Limestone, Lincoln. Back. (Page 361.)
7. *Turbo Davoustii*, d'Orbigny. *Parkinzoni*-zone, Aston. Back and front. (Page 360.)
8. *Delphinula alta-bicarinata*, sp. nov. Base of Lincolnshire Limestone, Lincoln. Front and back. (Page 362.)
9. *Delphinula alta-acanthica*, sp. nov. Same horizon and locality. Back and front. (Page 363.)
10. *Delphinula alta-acanthica*, var. *depressa*. Same horizon and locality. Back and front. (Page 363.)
11. *Delphinula Buckmanni*, Morris and Lycett. Oolite Marl, Nailsworth. Front and back. (Page 364.)
12. *Turbo* (*Delphinula*) *Shaleri*, Tawney. *Concavus*-bed, Bradford Abbas. Back and front. (Page 365.)
13. *Delphinula* or *Turbo*, species or variety. Inferior Oolite, Dorset. Front and back. (Page 366.)
14. *Delphinula Shaleri*, var. *pulchior*. Stoford. Back and front. (Page 366.)
15. *Delphinula angulata*, sp. nov. *Murchisonæ*- or *concavus*-zone, Half-way House. Back and front. (Page 367.)
16. The same; depressed variety. *Opalinus*-zone, Drympton. Front and back.
17. *Delphinula* (*Turbo*) *granata*, Hudleston. Dogger, Blue Wyke. Front and back. (Page 368.)

18, 18 *a*. *Delphinula* (*Turbo*) *Santonis*, sp. nov. Lincolnshire Limestone, Santon. Jermyn Street Museum. Back and front. (Page 369.)

PLATE XXX.

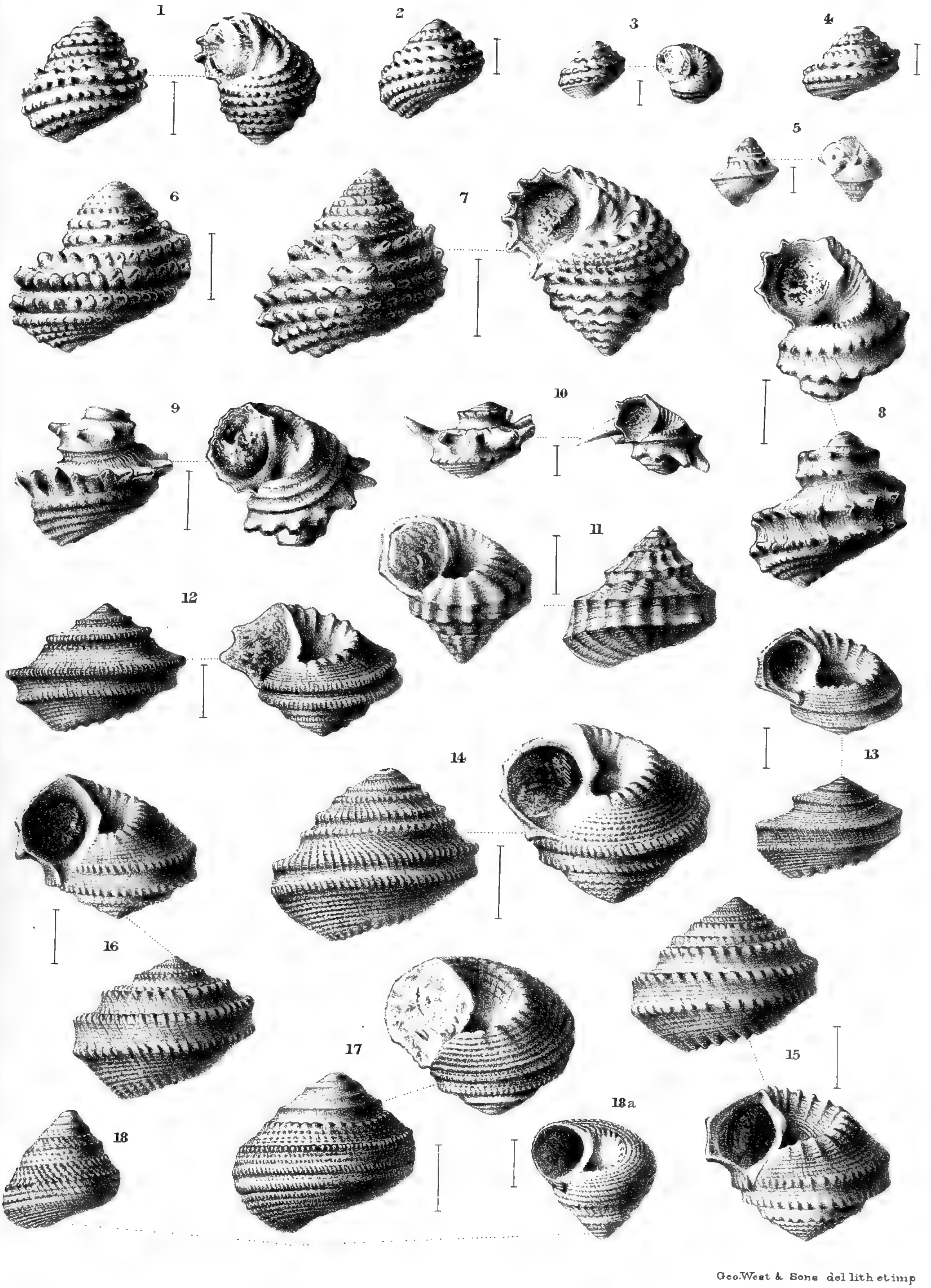

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PLATE XXXI.

N.B. 1. *All figures on this plate are drawn from photographs.*

N.B. 2. *All specimens are from my Collection unless otherwise stated.*

N.B. 3. *All figures are magnified a little over two diameters except fig.* 16.

Fig.

1. *Trochus Sandersii*, Tawney. *Murchisonæ*-zone, Bradford Abbas. Back and front. (Page 370.)
2. *Trochus rupestris*, sp. nov. Irony Nodule-bed (*Murchisonæ*-zone), Burton Bradstock. Back. (Page 371.)
3. *Trochus sybilla*, sp. nov. *Opalinus*-zone, Drympton. Back and front. (Page 371.)
4. *Trochus Winwoodi*, Tawney, var. *minor*. Stoford (*? Concavus*-bed). Back and front. (Page 372.)
5. *Trochus Winwoodi*, Tawney, var. *major*. *Concavus*-bed, Bradford Abbas. Back and front. (Page 372.)
6. *Trochus spiratus*, d'Archiac. Lincolnshire Limestone, Weldon. Front and back. (Page 378.)
7. *Trochus spiratus*, conical variety. Weldon. Back. N.B.—This specimen, like so many of the Weldon fossils, has suffered from attrition.
8. *Trochus dimidiatus*, Sowerby. *Parkinsoni*-zone, Woolston. Front and back. (Page 379.)
9. *Trochus Zetes*, d'Orbigny, as identified by Tawney. *Concavus*-bed, Bradford Abbas. Back and front. (Page. 379.)
10. *Trochus duplicatus*, Sowerby. *Parkinsoni*-zone, Burton Bradstock. Back and front. (Page. 373.)
11. *Trochus angulatus*, Sowerby [? var. of *T. duplicatus*, Sow., cf. also *T. Lorieri*, d'Orb.]. *Parkinsoni*-zone, Burton Bradstock. Back and front. (Page 374.)
12. *Trochus Duryanus*, d'Orbigny. *Parkinsoni*-zone, Grove. Back and front. (Page 375.)
13. *Trochus subduplicatus*, d'Orbigny. Small form from the "Sands," Brimscombe. Back. (Page 375.)
14. The same. Large form from the "Sands," Newton, near Yeovil. Front.
15. "*Trochus bicingendus*," Lycett. Oolite Marl, Nailsworth. Jermyn Street Museum. Back. (Page 389.)
16. *Trochus* cf. *Bixa*, d'Orbigny. Base of the Lincolnshire Limestone, Lincoln. Front. × $1\frac{1}{2}$. (Page 388)

PLATE XXXI.

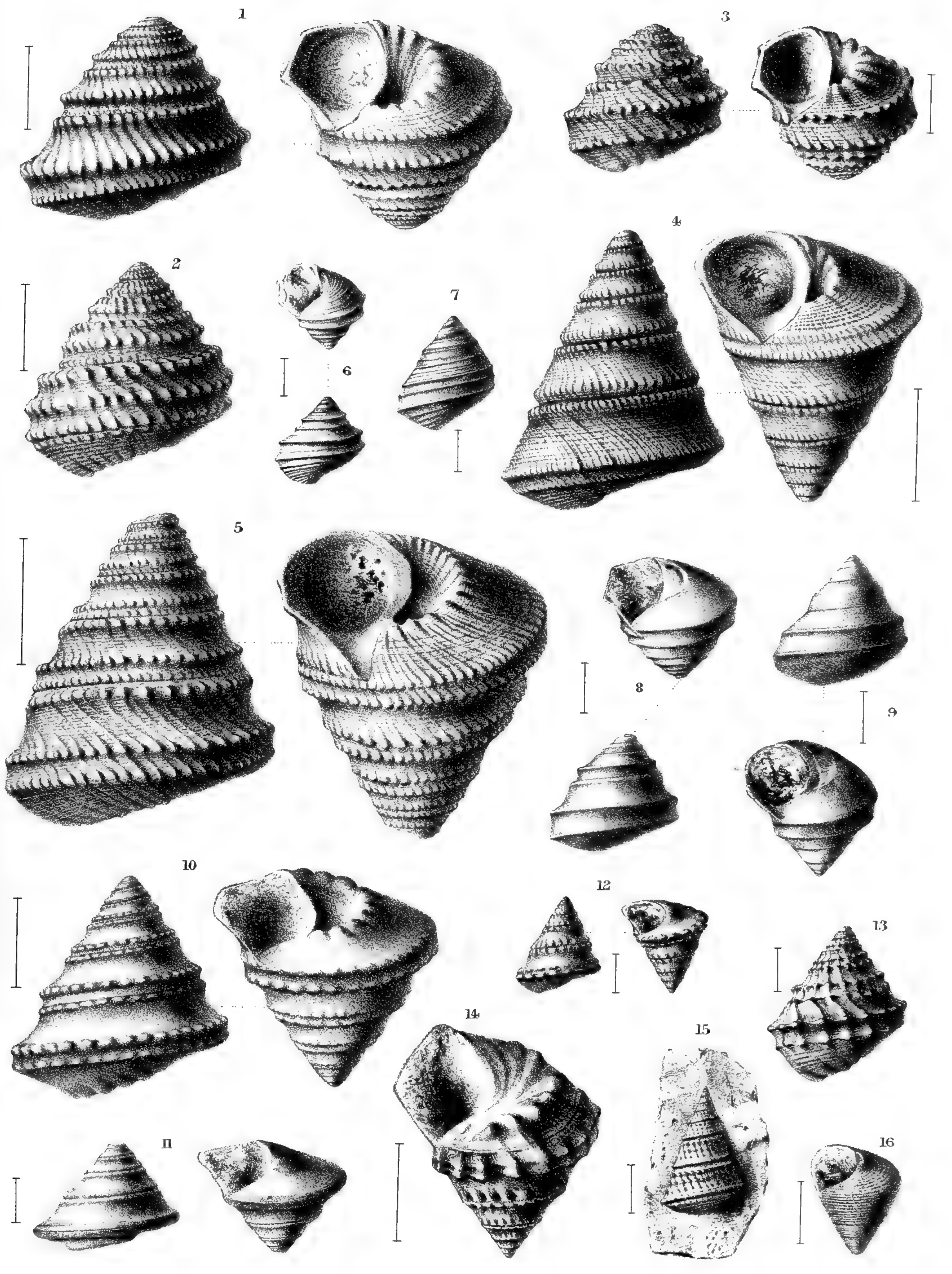

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PLATE XXXII.

N.B. 1. *All figures, except figs.* 3 *a*, 3 *b*, 13, *and* 18 *b*, *are drawn from photographs.*

N.B. 2. *All specimens are from my Collection unless otherwise stated.*

N.B. 3. *The majority of the figures are magnified a little over two diameters.*

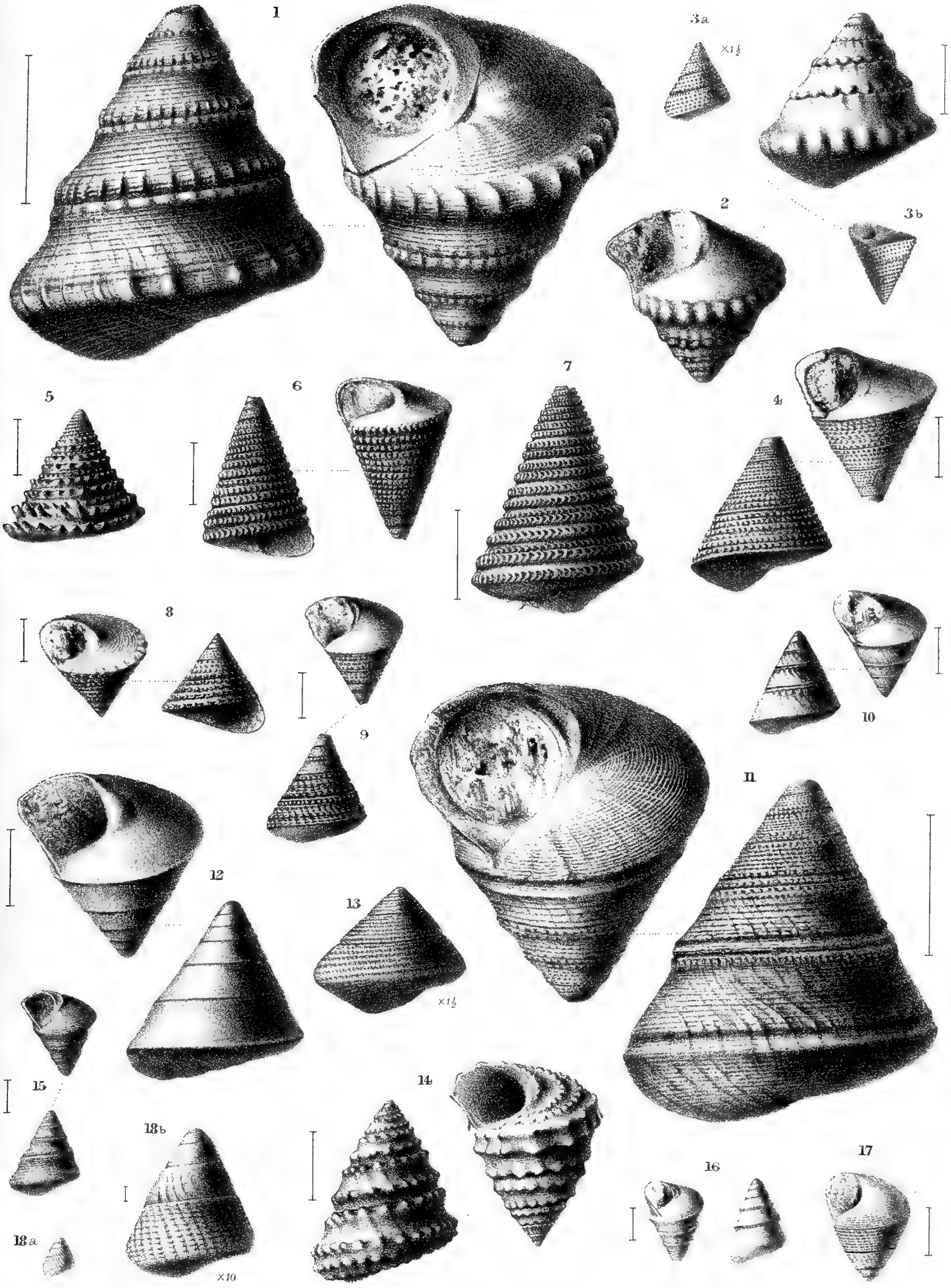
Fig.

1. *Trochus subduplicatus*, d'Orbigny, var. *Abbas*. *Concavus*-bed, Bradford Abbas. Back and front. (Page 377.)
2. *Trochus subduplicatus*, var *plicata*, Goldf. *Dumortieria*-beds, foot of East Cliff, Bridport Harbour. Back and front. (Page 376.)

3 *a*, 3 *b*. *Trochus monilitectus*, Phillips. Scarborough Limestone. Bean Coll., British Museum. Back and front. (Page 380.)

4. *Trochus substrigosus*, sp. nov., incomplete form, say *T.* "*nemoralis*" by way of distinction. *Parkinsoni*-zone, Grove. Front and back. (Page 384.)
5. *Trochus squamosior*, sp. nov. Base of Lincolnshire Limestone, Lincoln. Back. (Page 382.)
6. *Trochus subluciensis*, sp. nov. Oolite-Marl, Nailsworth Hill. Front and base. (Page 381.)
7. The same; larger and coarser form. Irony Nodule-bed, Burton Bradstock. Back.
8. *Trochus squamiger*, Morris and Lycett. Freestones of the Oolite-Marl, Nailsworth Hill. Base and front. (Page 382.)
9. *Trochus vicinus*, sp. nov. Lincolnshire Limestone, Weldon. Front and back. (Page 383.)
10. *Trochus Dunkeri*, Morris and Lycett, var. *Weldonis*. Lincolnshire Limestone, Weldon. Front and back. (Page 383.)
11. *Trochus substrigosus*, sp. nov. *Parkinsoni*-zone, Burton Bradstock. Front and back. (Page 384.)
12. *Trochus Burtonensis*, Lycett; Inferior-Oolite variety. *Parkinsoni*-zone, Horton Hill. Front and back. (Page 385.)
13. ? *Trochus Leckenbyi*, Morris and Lycett. Scarborough Limestone. Leckenby Collection, Woodwardian Museum. Back. (Page 386.)
14. *Trochus biarmatus*, Münster. *Parkinsoni*-zone, Grove. Back and front. (Page 386.)
15. *Trochus marga*, sp. nov. *Parkinzoni*-zone, Burton Bradstock. Front and back. (Page 387.)
16. *Trochus* "*subimbricatus*." Lincolnshire Limestone, Weldon. Front and back. (Page 388.)
17. *Trochus Bixa*, d'Orbigny. Irony Nodule-bed, Burton Bradstock. Front. (Page 388.)

18 *a*. Micromorph of *? Trochus Niortensis*, d'Orb. Pea-grit, Crickley. Back. 18 *b*. The same × 10. (Page 388.)



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A MONOGRAPH

ON

CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

BY

WHEELTON HIND, M.D., B.S.Lond., F.R.C.S., F.G.S.

PART I.

CARBONICOLA (ANTHRACOSIA).

PAGES 1—80; PLATES I—XI.

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A MONOGRAPH

ON

CARBONICOLA, ANTHRACOMYA, AND NAIADITES.

§ I. INTRODUCTION.[1]

The fossils to be described in this Monograph are obtained, almost without exception, from the productive Coal-measures of the Carboniferous Series; whether they occur, as in Scotland, the North of Ireland, and the North of England, at the base of this formation, as well as in the Coal-measures proper; or, as in the other coal-fields of Ireland, the remainder of England and Wales, and the Continent, above the Millstone-grit, in the upper beds. They chiefly occur in ironstone bands or nodules in indurated marl, and in black carbonaceous shales, and often in such profusion as to constitute shell-beds which extend over large areas.

On the Continent it is found that the genera occurring in the Coal-measures pass up into beds of Permian age; but it is doubtful at present whether it can be shown that the same species survived through both periods.

It is not within the scope of this Monograph to attempt the correlation of the various strata found in the different coal-fields of Great Britain; indeed, the Author believes that it would be impossible to do so, from the fact that the nature and thickness of the coal-seams and intervening beds undergo such alterations in the same coal-field that the conditions affecting the deposit must have been very

[1] In working up the Bibliography of the bivalve Mollusca of the Coal-measures I have been reluctantly obliged to acknowledge that in two at least of the three genera to be described in this Monograph the names now in use must be abandoned for others which have the priority. M'Coy's name of *Carbonicola*, though accompanied by a partly erroneous diagnosis, is undoubtedly a few months older than King's *Anthracosia*, in which, too, the hinge characters described belong to a species, and not to the genus. And also there is no doubt that Prof. J. W. Dawson's *Naiadites* is older than Salter's *Anthracoptera*, although Dawson's genus originally contained members of all the genera to be described in this work.

local. I adopt the table published by Professor E. Hull in his paper[1] ('Quart. Journ. Geol. Soc.,' vol. xxxiii, 1877, p. 615), as being the result of many years' labour on the Carboniferous Series of Great Britain by the greatest authority on the subject, and because I think the various stages proposed by him are well marked out by their fossil contents; and therefore they form the best scheme for the comparison of the various horizons in different coal-fields.

THE BRITISH CARBONIFEROUS SERIES.[2]

Beds, in Descending Order, with Localities.

	Name of Formation.	*Localities.*
Essentially Fresh-water and Estuarine Beds.	STAGE G. *Upper Coal-measures.*—Reddish and grey sandstones, breccias, and clays, with thin coal-seams and limestones. Fossils (fresh-water or estuarine).—Fish (migratory); Crustacea, *Leperditia inflata;* Annelids, *Spirorbis carbonarius.*[3]	Manchester, Stoke-on-Trent, Newcastle-under-Lyne, southern part of Dudley Coal-field; Banks of the Dee, near Ruabon; Hamilton and Ayrshire, in Scotland.
	STAGE F. *Middle Coal-measures.*—Yellowish sandstones, clays, and shales, with thick coals. Fossils (fresh-water or estuarine).—Fish (migratory); Molluscs, *Anthracosia* (*Carbonicola*), *Anthracomya;* Crustacea, *Beyrichia, Estheria;* Annelids, *Spirorbis.* Marine species rare.	Central portions of all the coal-fields of England and Wales; Upper Coal-measures of Scotland.
Essentially Marine.	STAGE E. *Gannister Beds* (Phillips) or *Lower Coal-measures.*—Flagstones, shales, and thin coals, with hard siliceous floors (Gannister). Fossils (Marine).—Fish similar to those above (migratory); Molluscs, *Goniatites, Discites, Orthoceras, Posidonia* (sic), *Monotis, Aviculopecten, Anthracosia* (*Carbonicola*), *Lingula,* &c.	South Lancashire, North Staffordshire, North Wales, and South Wales.
	STAGE D. *Millstone-grit Series.*—Coarse grits, flagstones, and shales, with a few thin coal-seams. Fossils (Marine).—Similar to those of the Lower Coal-measures.	Uplands of Yorkshire, Lancashire, and Derbyshire, North Staffordshire, North and South Wales, &c.
	STAGE C. *Yoredale Series.*—Shales and grits, passing downwards into dark shales and earthy limestones. Fossils (Marine).—Including *Goniatites, Aviculopecten, Ctenodonta, Chonetes, Discina, Posidonomya, Productus,* &c.	Uplands and valleys of Lancashire, Yorkshire, and Derbyshire, North Staffordshire, Wales, &c.

[1] "On the Upper Limit of the essentially Marine Beds of the Carboniferous Group of the British Isles and adjoining Continental Districts; with Suggestions for a Fresh Classification of the Carboniferous Series."

[2] This table is inserted by the kind permission of Prof. Hull.

[3] The name *Spirorbis pusillus* is given in Etheridge's 'Catalogue of British Palæozoic Fossils.'

	Name of Formation.	*Localities.*
Essentially Marine (except Stage A in Scotland).	STAGE B. *Carboniferous Limestone.*—Massive limestone, passing northwards into several beds, with intervening shales and grits. FOSSILS.—Fish, Crustacea, Molluscs, Crinoids, Corals, &c., all marine species.	Wales, North and South; Derbyshire, Yorkshire, Cumberland; in Scotland, the Lower or Main Limestone.
	STAGE A. *Lower Limestone Shale and Calciferous Sandstone.*—Dark shales in some places; grits, conglomerates, and red sandstones and shales in the northern districts. FOSSILS (Marine).—*Spirifera cuspidata, Rhynchonella pleurodon*, &c.	South Wales, Northumberland, and Durham; in Scotland, "Calciferous Sandstone Series."
Fresh-water Beds.	BASIS. *Upper Old Red Sandstone.*—Yellow sandstones and conglomerates. FOSSILS (fresh-water).—Not well represented in England.	South Wales; Northumberland; Scotland (Dura Den); Ireland (Kiltorcan).

The marine or fresh-water origin of much of the Coal-measures has always been a disputed point. Palæontologists have hesitated to affirm the latter on account of the almost universal occurrence throughout the coal-fields of Europe, in some few beds at the base of the Coal-measures, of Unio-like shells with typically marine forms; but it is questionable whether the presence of the two forms together is not apparent only,—I say *apparent* because, in collecting fossils from coal-pits, there is always great difficulty in accurately determining, to within a few feet or inches, the exact bed where each one is obtained: very few indeed can be obtained *in situ;* the greater part are gathered from the spoil-heaps, where accurate reference to any horizon is next to impossible. A fresh-water bed a few inches thick would pass unnoticed, and its fossils be mixed with those from marine beds above or below it. Many very thin beds containing fossils peculiar to themselves are known to occur at many geological horizons; and, as I shall describe hereafter, certain narrow bands, containing a typical marine fauna, do occur in the Upper Carboniferous strata, only to be recognised as of marine origin by their fossil contents. So that I conceive it to be highly probable that thin fresh-water bands exist amongst the marine beds at the base of the Coal-measures, a series universally recognised as one deposited under changing conditions; and this view is borne out by Prof. Phillips ('Encyclop. Metrop.,' 1834, p. 590), who describes two bands of Unios in the Gannister Series of Lancashire.[1]

A mixture of marine and fresh-water forms in any bed may be brought about in several ways. It is highly probable that fresh-water forms would be washed down by currents and deposited with marine forms near the bar of the river in

[1] Vide *postea*, p. 15.

which they lived; or the periodical inundations of the sea might distribute marine forms in such a manner that they would be deposited in the same beds with fresh-water forms; or a river cutting its way through slightly older marine beds might re-deposit fossil forms with those living in its waters,—indeed, stratigraphical evidence as to condition is so liable to be misinterpreted, and so many different factors may have been introduced, causing a *mélange* of marine and fresh-water fauna, that more stress is to be laid on biological evidence, which, perhaps not itself altogether satisfactory when only a single genus is taken into account, becomes more satisfactory as other genera are brought forward as evidence of the main or predominant conditions existing during the deposition of any bed containing them. When, in addition to strong presumptive evidence, the great bulk of stratigraphical observations in the majority of cases would seem to show that the beds in which the genera Carbonicola (*Anthracosia*), Anthracomya, and Naiadites (*Anthracoptera*) occur are not of marine origin, from the all but universal absence of typical marine forms, it would appear to be safe to affirm a fresh-water or estuarine habitat for them.

With regard to the views of Scotch geologists on this point, I quote from Dr. John Young's memoir "On the Carboniferous Fossils of the West of Scotland" ('Trans. Geol. Soc. Glasgow,' vol. iii, 1871, p. 44), where he says, speaking of the so-called Coal Unios, "None of the shells or other fossils of the marine limestone series are found in the same beds with this group of molluscs; and it has occurred to me that in the one or two instances in which a single example of *Anthracosia* is said to have been found associated with marine shells it may have been drifted from its proper habitat, or washed out of some older bed of fresh-water strata." And again, in 1880 ('Trans. Geol. Soc. Glasgow,' vol. vi, p. 223), "As far as Scotland is concerned, I have never observed any commingling of true marine fossils in any of our mussel-band beds. The reptiles, fishes, molluscs, annelids, ostracods, and other organisms belong to genera and species that are seldom or never met with in marine limestone strata. This being the case, I believe the opinion formerly entertained, as to the marine origin of the strata of our Upper and Middle Coal-measures, especially of the bed characterised by *Anthracosia*, was an opinion based on faulty observation, and which will yet be proved to be untrue when the fossils occupying each horizon of strata come to be critically examined. Oscillations of the earth's crust may bring strata, which have been deposited under either lacustrine or estuarine conditions, into very close contact with those of true oceanic deposits, and this may be repeated again and again in the same series of beds. It becomes, therefore, the work of the palæontologist to say which of the organisms found in this commingling of beds properly belong to the sea, and which to lakes and rivers."

This is most valuable evidence, as beds of coal and ironstone occur in the

Carboniferous Limestone Series of Scotland when there is a frequent alternation of beds with a typically marine fauna with those containing *Carbonicola* and its congeners.

The Penneystone Limestone of Coalbrookdale, in which occur typically marine shells—*Edmondia*, *Sanguinolites*, *Schizodus*, and *Brachiopoda*, together with *Anthracosia* and *Naiadites* (the "Unios" of Professor Prestwich), would appear to be an exception to this view. There is, however, evidence to show that the Unio-like shells contained in this probably mainly marine bed had been washed down into it, on account of the occurrence of typical land plants in the bed. The marine fauna, too, is very interesting and characteristic, containing a much larger percentage of Lamellibranchiata than obtains in the Carboniferous Limestone as a rule, and probably indicating very shallow water and a littoral deposit. The marine fauna closely resembles that found in the Redesdale ironstone of Northumberland, with the exception that the latter does not, so far as I can learn, contain the Unio-like forms; in the "Chance Penneystone" of Coalbrookdale, where marine forms again appear, *Carbonicola,* &c., are conspicuously absent; and conversely, at the other horizons at which these shells are found, marine forms do not occur.

This view was held by Prof. Prestwich, who, in his memoir on the 'Geology of Coalbrookdale,'[1] says, "We find . . . . evidences of strong river action in the presence of transported vegetables . . . . and fluviatile shells, intermingled with the marine Testacea of the sea into which they were drifted." And again, in a note at p. 466, referring to the mixture of marine and fluviatile forms, and the question of their identification by the presence or absence of eroded beaks, "I have examined a considerable suite of shells apparently belonging to this genus (Unio), but, as they are all casts in ironstone, I have not been able to come to any very decided opinion; nevertheless the greater number of specimens exhibited no trace of erosion, but a few, and amongst them several from the Penneystone, decidedly did,"—an observation which I shall illustrate in shells from the North Staffordshire Coal-field.

Speaking of the probable condition under which the Coal-measures of Coalbrookdale were deposited, Sir R. I. Murchison says:[2]

"Doubtless, therefore, as hinted at in the preceding chapter, this tract of Coalbrookdale must originally have been a bay of the sea, into which streams of fresh water discharged materials derived from those lands, the contiguity of which has been previously inferred from the existence of fresh-water limestone in the adjacent coal-fields. This view is also quite in accordance with that of Mr. Prestwich, who is of opinion 'that the alternations of fresh-water shells with

[1] 'Trans. Geol. Soc. Lond.,' ser. 2, vol. v, pt. 3, 1840, p. 469.

[2] 'Silurian Syst.,' p. 105.

marine remains do not prove as many relative changes of land and sea, but that the Coal-measures were deposited in an estuary, into which flowed a considerable river, subject to occasional freshes; and he conceives that this position is supported by the fact of frequent alternations of coarse sandstones and conglomerates with beds of clay or shale containing the remains of the plants which have been brought down by the river."

A very important statement is made by the officers of the Geological Survey in the large memoir 'The Geology of the Yorkshire Coal-field,' p. 14:—"The few mollusca met with may be divided into two groups. One group contains shells, such as *Anthracosia* and *Anthracomya*, which are allied to recent fresh-water forms; the other group consists exclusively of marine genera, such as *Aviculopecten*, *Posidonomya*, and *Goniatites*. These two groups have never yet been found together, and the marine forms occur only on a few horizons and in beds of no great thickness;" though this evidence is rather discounted by the notice (at p. 85) of a section at Hoarstones Road showing black shale with *Anthracosia acuta*, *A. robusta*, var. B, *Aviculopecten papyraceus*, *Goniatites*, and scales of *Palæoniscus*.

The absence of *Carbonicola* (*Anthracosia*) and its allied forms from the Gannister-beds of Lancashire and Yorkshire, stage E of Professor Hull, and, indeed, with one or two exceptions, from the whole of stage E, is very marked; and I have reason to believe that he may have been misinformed by local collectors as to the true genera of the specimens: many shells which have been shown to me from these beds as *Carbonicola* and *Naiadites* I have found to be crushed specimens of *Schizodus*. This was the case with a shell figured by Mr. George Wild ('Trans. Manch. Geol. Soc.,' pt. 13, vol. xxi, pl. ii, fig. 7). I have been permitted to examine this specimen, and have no doubt as to its being *Schizodus Salteri;* and as the same shell occurs in the North Staffordshire Gannister-beds, I think it exceedingly probable that either this shell or perhaps a true *Modiola*, which is found in the Wetley Moor ironstones, has been mistaken for *Naiadites*. Strange to say, Prof. Hull has made no mention of *Anthracosia*, &c., occurring in the Penneystone of Coalbrookdale (stage E); while, as to the occurrence of *Anthracomya* in this stage in Glamorganshire, as quoted by him, this horizon is not given by Salter ('Iron Ores of Great Britain,' pt. 3, 1861).

It is important to note that in the thin marine bands of the Upper and Middle Coal-measures, with a characteristic marine fauna, differing much from that of the Gannister, especially in the paucity of Lamellibranchiata, Carbonicola (*Anthracosia*), &c., never occur.

In the North Staffordshire Coal-field there are at least two well-recognised marine beds. The one "the Gin Mine," or "Golden Twist," containing—

Goniatites excavatus, Phil.	*Solemya primæva*, Phil.
„ *striatus*, Phil.	*Chonetes Laguessiana*, De Kon.
„ *multilobus*, Phil.	*Nucula gibbosa*, Flem.
Cypricardia glabrata, Phil.	„ *lineata*, Phil.
Aviculopecten, sp.	*Machrocheilus Michotianus*, De Kon.
Euomphalus tuberculatus, Flem.	*Bellerophon Dumontii*, F. d'Orb.
Pleurotomaria, sp.	*Leda clavata*, M'Coy.
Productus semireticulatus, Mart.	*Loxonema*, sp.
Spirifer Urei, Flem.	*Ctenodonta*, sp.
Axinus (*Schizodus*), sp.	*Discites subsulcatus*, Sow.
Orthoceras, sp.	

The other bed, occurring above the "Knowles seams" and immediately overlying the "Bay Coal," was discovered by Mr. John Ward, of Longton, in a sinking at the Foley colliery, and he states in his work on the Geology of the North Staffordshire Coal-fields,[1] "After a careful search I have failed to discover in the North Staffordshire Coal-field mollusca of a fresh-water type in direct association with those of a marine facies. In every instance where the two have approached each other the line of demarcation has been clear and distinct."

Even the beds over the Four-Foot coal of Wetley Moor and Biddulph, the beds containing *Lingula* and *Goniatites* are perfectly distinct from those containing *Carbonicola*, both in their horizon and lithological character—a fact I have been able to observe very recently in a sinking near the top of Eaves Lane, Wetley Moor.

The following fossils occur in the Bay Coal band :

Aviculopecten papyraceus, Sow.	*Machrocheilus*, sp.
Ctenodonta, sp.	*Nautilus* (*Discites*) *falcatus*, Sow.
Discina nitida, Phil.	*Productus*, sp.
Lingula squamiformis, Phil.	*Spirifer*, sp.
„ *mytiloides*, Sow.	

Another such marine band in the banks of the Tame at Ashton-under-Lyme was discovered by Prof. A. H. Green, and a list of the contents is given by Mr. Salter in the Memoir on the Country round Oldham,[2] which I quote here.

Calamites, narrow ridges.	*Discites rotifer*.
Wood.	„ sp. 2.
Serpulites.	„ sp. 3.
Aviculopecten fibrillosus.	*Goniatites*, sp.
„ *papyraceus*, Goldf.	*Orthoceras*, sp., thin.
Ctenodonta, sp.	*Megalichthys Hibberti*, Agass.
Nautilus præcox.	

[1] 'Trans. North Staffs Institute of Min. and Mech. Engineers,' vol. x, pt. 5, 1890, p. 49.

[2] 'Geol. Surv. Mem.,' "Geology of the Country round Oldham," 1864, p. 64.

The same writer is responsible for the following statement in his Appendix to the 'Geol. Survey Memoir, Country round Wigan,' 2nd edition, 1862, p. 43:—"With *Goniatites*, *Anthracosia* occurs in abundance, not actually discovered in the same layers, but closely intermixed, so that it is difficult to believe that one is a fresh- and the other a salt-water shell." No other observer has made a similar statement; but he goes on to say, "*Anthracosia acuta* occurs in strata undoubtedly marine at Clitheroe;" and names the discoverer—a statement which is very vague as regards locality and horizon; and, as the specimen itself is not in evidence, it is impossible to place much reliance on this solitary find, which was probably another bivalve from the Carboniferous or Yoredale beds.

There are at least two beds in Scotland in which *Carbonicola* (*Anthracosia*) and undoubted marine fossils appear to occur together; one of these is the "Slaty-band" or "Lingula-ironstone" of Lanarkshire, which contains—

Lingula mytiloides.	*Anthracosia* (*Carbonicola*) *aquilina.*
„ *squamiformis.*	„ „ *acuta.*
Anthracosia (*Carbonicola*) *subconstricta.*	

('Mem. Geol. Survey Scotland,' Explanation of Sheet 23, pp. 89, 90, 1873.)

This bed is probably equivalent to the Gannister Series in England, and belongs to stage E.

The other bed is that at the base of the "Cement-stone Group" at Water of Leith, from which Dr. Rhind[1] and Captain T. Brown[2] have obtained a shell, according to the former, "from a bed of shale below ten feet of sandstone, but the marine character of the bed is not made out, and it is very probable from the plant remains in the Cement-stone Group that these beds are not marine. R. Etheridge, jun.,[3] records a similar shell (the original having been lost, the reference is somewhat doubtful) from hardened shale in a quarry on the north side of the Colinton Road, under Craiglockart Hill, near Edinburgh, at about the same horizon.

It has generally been considered that *Anthracoptera crassa* (the *Myalina crassa* of Fleming, Etheridge, and others), which I have shown to be anatomically identical with the Naiadites (*Anthracoptera*) of the Coal-measures,[4] is a marine shell. It occurs at Cults, Pitlessie, Fife, in a bed almost completely composed of these shells, at the west end of the workings, now almost covered with talus; but there are several broken specimens lying about with corals (*Zaphrentis*), *Aviculopecten*, fish remains (*Megalichthys*) and *Stigmaria*—a curious fauna, indicating the

[1] Rhind, 'Age of the Earth,' p. 167, pl. ii, figs. *a*, *b*.

[2] 'Ann. and Mag. Nat. Hist.,' ser. 1, vol. xii, pl. xvi, fig. 1, p. 394; 'Fossil Conchology,' p. 178, pl. lxxiii, fig. 8.

[3] 'Quart. Journ. Geol. Soc. Lond.,' vol. xxxiv, pl. ii, fig. 20, p. 16, 1878.

[4] Hind, 'Geol. Mag.,' Decade III, vol. x, Nov., 1893, p. 514.

proximity of land. The shells of *Naiadites* (*Anthracoptera*) are very large and fine; and whatever conditions obtained, they were very favorable to the growth and life of the species. As to Beith, the other locality where this shell occurs, Mr. Robert Craig writes me that it is a rare shell there except in two places, where it existed in large colonies, at Roughwood in a shale averaging three feet in thickness, which rests on a bed of coal and is very fossiliferous. The lowest two inches contain a mixture of marine and brackish water forms, above which the fossils are marine. In the Beith quarries *Myalina* is found in a shale ten inches thick, which rests on a coal, and is associated with fish remains, of brackish water origin. The real nature of these beds is therefore quite open to question. In the brackish or possibly fresh-water beds of the Cement-stone Group occurs a slighter form, which Mr. Robert Etheridge, jun., describes[1] as of slighter make than those from Cults; and he refers it to the form described by Captain Thomas Brown as *Avicula modioliformis;*[2] but he says "I cannot distinguish any characters, either external or internal, by which specifically to distinguish Captain Brown's shell from Dr. Fleming's, and I propose to adopt the name given by the former as a varietal designation for the thinner and lighter form of *Myalina crassa*."

It is quite possible that the change in size was merely due to change in environment, and that we have here an example of a species, originally marine in habitat, growing luxuriantly under marine littoral conditions, but dwindling rapidly in size, and passing off into varietal forms, under the fresh-water conditions of the Middle and Upper Coal-measures.

The universal absence of marine forms of life in the Middle and Upper Coal stages F and G throughout the coal-fields of Europe is very striking, and Continental geologists are almost unanimous in considering *Carbonicola*, *Anthracomya*, and *Naiadites* to have had a fresh-water habitat. Doubt has been thrown on this point by Salter,[3] who says, "Meantime there is yet more doubt if they can be fresh-water forms, associated as they always are with *Modiola* and other true sea animals,"—a statement certainly not borne out by observation. The association with true marine animals is certainly not "always," and the word "rarely" might have been substituted for it with greater approach to truth. But I shall show later on that Salter was led to misinterpret and neglect several previously observed and obvious anatomical facts in order to establish *Anthracosia* and his new genus *Anthracomya* as marine forms. Prof. Hull[4] states, "These bivalves (the *Anthracosia* of King) are the bane of palæontologists, and after a long consideration of their relationship to other fossils in Carboniferous strata,

[1] 'Quart. Journ. Geol. Soc. Lond.,' vol. xxxiv, p. 13, 1878.

[2] 'Foss. Conch.,' 1849, p. 162, pl. lxvi, fig. 19.

[3] 'Geol. Survey Mem.,' "Iron Ores, South Wales," pt. iii, p. 227, 1861.

[4] Supra cit., 'Quart. Journ. Geol. Soc.,' vol. xxxiii, p. 643.

and their very varying forms, I have come to the conclusion that either they were capable of inhabiting both lakes and estuaries on the one hand, and the open sea on the other, or else the marine and fresh water forms are so similar in appearance that they can only be identified by reference to those which may occur along with them in the bed. Thus when, (as in Coalbrookdale and Lancashire), [I doubt the latter locality[1]] we find them associated with undoubted marine forms, we can only conclude that they themselves were inhabitants of the sea; but if they happen to occur unaccompanied by such well-recognised forms, then we may assume that they represent lacustrine or estuarine conditions, the probability being that had the strata been formed under the sea marine shells would have been preserved along with those of this genus." I have shown above that the mixture of marine forms with *Carbonicola* (*Anthracosia*) is by no means so common as might be supposed from this remark, and that it may be accounted for in other ways than those advanced by the Professor; and I am sure that the true reason of this group of shells being a "bane to palæontologists" is because they have never been systematically collected and studied. It is perfectly astonishing to see the paucity of specimens of these shells in museums, and more so in the museums of large towns situated in coal-measure districts. It is, indeed, a matter of very considerable difficulty to obtain these fossils *in situ*, and unless the greatest care is observed, and the collector possesses an intimate acquaintance with the naked-eye characters of the various shells and rocks on the waste-heaps, it is very easy to infer that fossils which lie close together on the mound, belonging to widely separated beds, are from the same horizon. Another obstacle arises from the carelessness of many collectors in not labelling each specimen immediately it has been brought home, and often putting them by with others, so that shells from various beds become mixed and the horizons forgotten. I can testify myself to the frequent difficulty and almost impossibility of arriving at any but the approximate horizon of many specimens; often I have found some of my best specimens lying weathered-out on the rubbish-heap of a pit-bank years after the pit has ceased working, and which, from the hardness of the matrix and

[1] On the authority of Prof. Phillips (article on "Geology," 'Encyclopædia Metropolitana,' 1834, p. 590), who, in speaking of the marine shells in the Lower Coal-measures of Lancashire and Yorkshire, says, "In the midst of this series of Gannister Coal two layers of these shells [Unio] occur, one of them about the middle of the series, considerably above the Pecten Coal, and the other near the bottom, considerably below that coal." This extract is quoted by Binney in two papers on "The Marine Shells of the Lower Coal-measures" ('Manchester Geol. Soc. Trans.,' vol. i, p. 82, 1841; vol. ii, p. 75, 1860). Mr. Bolton, assistant keeper of Owens College Museum, writes me:— "In the Rossendale area of the lower coal-measures a very persistent bed of ironstone shale with ironstone, the whole charged with Carbonicola in the state of casts, occurs immediately over the Bassey or Salts Mine. The same bed has been found at Helpit Edge, Saddleworth. I am sure that careful search would prove its existence in the Haslingden district."

small size of the specimen, it would have been practically impossible to procure when the portion of the bed containing them was brought to the bank. It is also, unfortunately, only too true that miners are very fond of deceiving collectors, and handing them specimens which have been obtained from quite different localities; and had I not known the rocks and localities well, I might often have been deceived by marine fossil forms (often Carboniferous) said to have been obtained from certain horizons, which, happily I knew, could not have been the case.

A strong point in favour of the fresh-water origin of much of the coal-measures is brought forward by Prof. A. H. Green ('Coal and its Uses,' edited by Thorpe, 1878, p. 31). When discussing the want of unanimity among observers on this subject, and the distinction of the fauna of the Carboniferous Limestone from that of the Coal-measures, he says, "They [the fauna] are rarely, if ever, found together. One, we know, was marine; is it not, then, to say the least, likely that the other was fresh-water?" And in support of this view he says, "No marine amphibian is known, and we may therefore conclude that these [Labyrinthodonta] were fluviatile in their habit."

In the same volume, p. 154, Prof. Miall, speaking of the same subject, says an examination of the fossils of the Coal-measures, apart from marine bands, gives a result strongly in favour of the fluviatile or terrestrial origin of the bulk of the Coal-measures; and in adopting this conclusion we have no difficulty to face, except that implied by the supposition that the Elasmobranchs were more largely fluviatile than in other periods."

To sum up then, on the whole, very little positive evidence can be brought forward on behalf of a marine habitat for these shells; while there is, to say the least, a fair amount of presumption that they lived under fresh-water conditions. It may be, however, that we have in the occurrence of *Carbonicola* and *Naiadites* with various marine forms at the base only of the Coal-measures, an example of a genus changing its habitat. It is probable that all molluscan forms were originally marine in habit, and that by modification and adaptation some few forms became able to exist in fresh water; and it is also probable that this adaptation took place at different times, and is even going on now,—to wit, the discovery of *Hydrobia Jenkinsi* in inland canals of late years, which shell had till that time been only known under estuarine conditions.

§ II. CRITICAL BIBLIOGRAPHY.

The literature of this subject, though scattered, is fairly extensive; but unfortunately authors have worked independently, and not consulted previous writings: and this fault is much more marked amongst the Continental palæontologists, some of whom, writing within the last thirty years, have ignored all the work done in Great Britain; and, failing to grasp the number of varietal forms which the shells under notice are capable of assuming, have described each small variation as typical of a different species.

1720. The earliest literary trace of these Coal-measure shells that I am able to discover goes back as far as 1720, in a work entitled 'Memorabilia Saxioniæ Subterraniæ," by G. F. Myles, published at Leipzig, a work of high artistic and palæontographical value in the accuracy and detail of its many plates of fossil plants and prehistoric remains. Only one plate, however, refers to the subject of the present memoir, pl. xxvi, figs. 1, 9, 10, with a short description at p. 39, which I here transcribe. The quaint mingling of Latin and German, and reference to the Unio-like character of the fossils, are of interest:

Fig. 1. "Patellæ seu conchæ pictoriæ werden darum die auf diesen Stein sie præsenterenden Muschelen genennt, weil sie der Mahler gar sehn zu gebrauchen pflegen, daher sie auch in L. 17, ff. de instr. et instrum. leg. als instrumenta pictorum angeschen werden. Nicht weniger finden sich auf diesen Stein noch eine Art, welche Dactyli, germ. Känel-Nagel, oder Finger-Muscheln und Schalen heissen, deren Plinius, Lib. 9, cap. 61, gedenckt."

Fig. 8. "Die Muschel so allhier sich zeiget, ist gleichfals mit dem sub. fig. 1, erwehnten Dactylis zu vergleichen immassen auch die Selb."

Fig. 10. "In copia communicerten denen Patellis f. conchis pictoris, obschon nicht in dergleichen Grösse, über einkommen."

The former two figures refer to *Carbonicola*, the latter evidently to *Naiadites*. It is interesting to note in this earliest account the occurrence of these two genera together, and the reference of these fossils to Unio. It will be seen that the older writers on this subject were all of this opinion, and many Continental authors have continued to hold this view.

1793. From 1720 to 1793 I can find no mention of Coal-measure shells; but in that year the Rev. David Ure published his 'Natural History of Rutherglen,' a lasting testimony to his acuteness of observation and scientific mind. He describes certainly one shell now referred to *Carbonicola*, and possibly four. He says, p. 311, "The marble in Rutherglen . . . abounds in mussels. . . . Some entire specimens are enveloped in till" (? marl). He figures a specimen, pl. xvi, fig. 4, which has the appearance of the *Carbonicola aquilina* of later authors;

and I am the more inclined to this view from the examination of a specimen from that locality in the possession of Dr. John Young, Curator of the Hunterian Museum, Glasgow. About the figures, pl. xvi, figs. 5, 6, I must say I have great doubt as to the shells they are intended to represent. Ure says, "Two species of mussel are found in Kilbride: those of the former are casts and rare; the latter are in ironstone and lie flat." The former is possibly *Naiadites*, the latter *Lingula*. He figures on pl. xv, fig. 2, a shell which more closely resembles *Anthracosia robusta* than anything else I know, of which he says, "The cockle is found very perfect in schists with Orthoceras, Encrinites, &c., at Black Craig and Thornley Bank." I have, however, never known *C. robusta* to be associated with marine forms in Scotland, and Mr. James Nielson tells me that *Carbonicola robusta* never occurs in this locality.

1809. The next to write on the subject appears to have been W. Martin, who brought out his 'Petrefacta Derbyensia' in 1809 at Macclesfield; and, although holding somewhat curious views of the true import of fossils, yet he was endowed with an acute observation. His figures and description are excellent; and his work is still a standard reference as containing the first descriptions and figures of many Carboniferous Limestone species. He seemed to consider that each fossil species was but the representation in stone of living forms, as is shown in his description, where he states, "The hinge (visible only in recent species), &c." He figures three specimens from ironstone, and I feel no doubt as to the form represented. The name "Conchyliolithus (*Mya ovalis*)" is given to it. It is here to be noted that the *Mya* of Linnæus equals *Unio* of Lamarck.

1813. Sowerby, in 1813, published the vol. i of his 'Mineral Conchology,' containing a plate of Coal-measure shells, tab. xxxiii, figs. 1—3, 5—7, with short descriptions, pp. 83, 84, under the names *Unio subconstrictus* and *U. acutus*. The other figure on this plate (fig. 4) is said to have been obtained from marl at Felmersham, Bedfordshire, an Oolitic locality. I have examined the original specimen in the Sowerby Collection in the British Museum (Natural History), South Kensington, and, from the matrix and characters, consider it to be a well-known Oolite shell; but, curiously enough, this Oolite shell, called *Unio uniformis*, was considered by Sowerby to be the same form as Martin's *Mya ovalis* from the Coal-measures of Derbyshire, and the name was substituted because the former was in use for recent shells.

1824. Defrance, in the 'Dictionnaire des Sciences naturelles,' vol. xxxiii, p. 295, in 1824 followed Sowerby, but suggested that, as nothing of the interior was known, the genus was doubtful, and that the various forms described were simply variations.

1828. Fleming, in his 'History of British Animals,' 1828, quotes *Unio acutus*, Sow., giving, however, the locality as Middle Oolite, and *Unio Urii*, referring

Martin's shell to this form. He also quotes *Mytilus crassus*, referring to his previous note on this form, as *Modiolus*, sp., in the 'Edinburgh Philosophical Journal,' vol. xii, 1825, p. 246.

1829. H. Bronn, "Verzeichniss der im Heidelberger Mineralien Komptoir," &c. In 'Taschenbuch für die gesammte Mineralogie' (Leonard's 'Zeitschrift für Mineralogie'), Jahrgang 1829, Bd. i, p. 76, 8vo., Heidelberg, 1829, is the following:

"363. ? *Unio carbonarius*, n.; ? *Mytulites carbonarius*, d."

That is to say, Bronn, in 1829, made Boné's species of *Mytulites* a *Unio*. Bronn, in his list, should have put "*Zeit. Leonard*" instead of "*Jb.*" d = Steinkohlen-Formazion.

1829. In the same year Höninghaus published a list of the fossils in the University of Bonn ("Verzeichniss der dem Museum der Universität, Bonn," &c., 'Petrefacten Sammlung'), mentioning at p. 17 *Mya tellinaria*, *Mya ventricosa* from Liége, *Mya minuta* from Camerberg, (*Mya?*) *Unio acutus*, Sow., from Bocheim, and *Mytilus crassus* (*Mya sulcata?*) from Werden.

1832. A. H. Dumont, in his 'Mémoire sur la Constitution géologique de la Province de Liége,' published in 1832, gives at p. 356 a list of fossils from the Upper Coal-measures, amongst which are—

	Locality.
Unio acutus, Sow. *Mya acuta*, Höninghaus.	Bougny; Jemeppe.
Unio subconstrictus, Sow. *Mya tellinaria*, Höninghaus. „ *ventricosa*, „	Le Val Benoit.

1834. Mammatt published his 'Geological Facts of the Ashby-de-la-Zouch Coal-field' in 1834, and alluded to beds full of *Mya ovalis*, figuring small portions and crushed shells on several plates; but none can be recognised owing to their fragmentary condition.

1835. Hibbert, in 1835, published his memoir on the Burdiehouse Limestone, figuring without description a shell from that bed as *Unio nuciformis*, of which, unfortunately, all trace has been lost.

1836. In 1836 W. C. Williamson alludes in the 'Philosophical Magazine,' vol. ix, p. 351, to a shell from the Spirorbis Limestone of Pendlebury as *Unio Phillipsii*, and, giving a detailed description but no figures, refers to Hibbert's work, and suggests the similarity of the two shells.

1838. In 1838 Dr. W. Rhind, of Edinburgh, issued his little book 'The Age of the Earth,' figuring on pl. ii, *c*, *d*, *e*, *f*, Unios from the Coal-shale of Polmont, Falkirk; figs. *a* and *b*, *Axinus Pentlandicus* (probably *Schizodus*), and fig. *g*, a modioliform shell, all from Woodhall, Water of Leith.

1839. In 1839 Murchison refers in his 'Silurian System,' p. 88, to a letter from Prof. Phillips, describing three Unios and one modioliform shell from Ardwick, the latter of which he figures, p. 84, fig. *c*, and gives a woodcut of *Unio acuta* on p. 105, fig. *e*, but he does not discuss further the nature of these shells. Prof. Phillips's letter is as follows:—"This is a small shell from the Spirorbis Limestone of Ardwick, and looks so like a young Modiola that I hesitate to call it Unio. Tumid shell with prominent beaks, smooth, but with lines of growth, short straight hinge. In the argillaceous beds associated with the limestones are three Unios. The most common of these is nearly elliptical, hinge-line deviates considerably from parallelism, with front ends in prominent angle, lines of growth strong, shell thin, beaks slightly prominent. Professor Williamson refers this to *Unio nuciformis* of Hibbert inaccurately. It occurs in red beds, above limestone, black bass, and underlying coal-measures.

"2nd Sp.—I have named *Unio linguiformis* (*U. Phillipsii* of Williamson), transversely elongated, three times as wide as long, hinge-line almost parallel to front lines of growth. Shell fine, thin, smooth. (Black bass.)

"3rd Sp.—*Unio rugulosus*, obliquely expanded, in semi-elliptical form, the hinge-line forming the diameter. Surface concentrically marked with broken undulations, showing radiations on posterior slope. Shell very thin, occurring in marls above limestones, black bass, and shale, beneath calcareous bands."

1833. Davreux, in his 'Essai sur la constitution géognostique de la Province de Liége,' published in 1833, remarks at p. 101, "Les Unios ou Myas, ou peut-être Lingulæ, se montre dans un grand nombre de nos Houillières. . . . Ces bivalves fluviatiles se trouvent toutes en toit des couches, et n'ont jamais un volume très considérable." He figures—

Unio acutus, Sow.,
,, *antiquus*, Sow., } pl. v, figs, 3, 4, 8,

the latter a very characteristic cast of the hinge.

1834. Prof. Phillips, in his article on "Geology" in the 'Encyclopædia Metropolitana,' p. 590, speaking of the bands of marine shells in the Lower Coal-measures of Lancashire and Yorkshire, says, "In the midst of this series of Gannister Coal two layers of these shells occur; one of them about the middle of the series, considerably above the 'Pecten Coal,' and the other near the bottom, considerably below that coal." This paragraph is quoted by Mr. Binney in two papers on the marine shells of the Lower Coal-measures, 'Manchester Geol. Soc. Trans.,' vol. i, p. 82; and vol. ii, p. 75.

1834—1840. Goldfuss published his 'Petrefacta Germanica,' p. 180, during the years 1834 to 1840, and he described and figured (tab. cxxxi)—

1.	*Unio abbreviatus*, Goldf.	From Liége.
2.	,, *utratus*, Goldf.	From Liége.
3.	,, *tellinarius*, Goldf.	From Liége.
4.	,, *subconstrictus*, Sow.	From Liége.
	,, *uniformis*, Sow.	From Kusel.
	,, *carbonarius*, Bronn.	From Kusel.

It had evidently escaped his notice that Sowerby states that his *Unio uniformis* did not occur in the Coal-measures, and, in addition, there is not the slightest resemblance between these two forms, as was pointed out later by de Koninck, and the name *Unio Goldfussianus* was given by him to Goldfuss's shell. I believe it really belongs to the genus *Anthracomya*. Goldfuss's description of the genus is evidently given from recent specimens. He enumerates as characteristic a pearly interior, eroded (*abgeriebenes*) umbones, cardinal lateral teeth; and he remarks that it is supposed because all recent forms inhabit fresh water that fossil forms indicate the same conditions, and that the Coal, Lias, and Oolite forms have been referred to this genus from external appearances, although their interiors are almost unknown. *Unio carbonarius*, Goldfuss, differs entirely from *Unio carbonarius*, Bronn. The originals of Goldfuss's figures are said to be in the museum at Bonn, but Professor Schlüter tells me that he has searched for the figured specimens, and they are not to be found. He states that there are a few named specimens, but so badly preserved and so fragmentary that no opinion can be based on them.

1840. It was in 1840 that Professor Prestwich published his paper on the Coalbrookdale Coal-field, in the Appendix of which James DeCarle Sowerby described and figured twenty species of bivalves from that district.[1] This paper was read, however, before the Geological Society on February 5th, 1834, and April 13th and 27th, 1836.

1. *Donax ? sulcata.*
2. *Venus ? carbonaria.*
3. *Nucula æqualis.*
4. ,, *accipiens.*
5. ,, *acuta.*
6. *Unio Urii.*
7. ,, *Ansticei.*
8. ,, *parallelus.*
9. ,, *dolobratus.*
10. ,, *modiolaris.*
11. *Unio phaseolus.*
12. ,, *aquilinus.*
13. ,, *centralis.*
14. ,, *robustus.*
15. *Modiola carinata.*
16. *Mytilus triangularis.*
17. *Avicula quadrata.*
18. ,, *modiolaris.*
19. *Pecten gentilis.*
20. ,, *scalaris.*

Of these, Nos. 1 to 8, and 19, 20, are marine forms. *Unio Urii* is certainly wrongly referred to Ure's shell; for it belongs to quite a different genus, probably *Edmondia*, to which also *Unio Ansticei* and *U. parallelus* may be referred.

[1] 'Trans. Geol. Soc.,' 2nd series, vol. v, 1840.

Of the remaining shells named *Unio*, Nos. 9 and 10 are now referred to *Anthracomya* (Salter), Nos. 11 to 14 to *Carbonicola* (M'Coy), while Nos. 15, 16, 17, and 18, described as *Modiola*, *Mytilus*, and *Avicula*, are now referred to *Naiadites* (Dawson). The figures are good and very typical, except in the case of *Carbonicola robusta* and *Anthracomya dolobrata*, which are from imperfect specimens.

1842. In 1842 S. Stutchbury ('Ann. and Mag. Nat. Hist.,' vol. viii, p. 481) proposed the name *Pachyodon* for certain Liasic and other shells which possessed a peculiar hinge-tooth, but he did not include any Coal-measure shells under this denomination; and it was from external appearance only that later on Captain Brown considered that the Coal-measure Unios might belong to this genus.

1842. In 1842 appeared Agassiz' translation of Sowerby's 'Mineral Conchology,' in which he proposed the name *Cardinia* for the shells of the Coal-measures previously described as Unios, considering them to be related to certain Jurassic forms.

About the same year (1842) de Koninck described and figured nine forms in his 'Des animaux fossiles du bassin Carbonifère de la Belge,' only one of which (*Cardinia nana*), which Geinitz thinks[1] belongs to *Estheria*, was mentioned for the first time. I am told by Professor Dewalque, of Liége, that these specimens are in the museum of Cambridge, Massachusetts. They are as follows:

Cardinia acuta.	*Cardinia nana.*
,, *subconstricta.*	,, *abbreviata.*
,, *atrata.*	,, *tellinaria.*
,, *robusta.*	,, *carbonaria.*
,, *phaseolus.*	,, *ovalis.*

He follows Agassiz in referring these forms to *Cardinia*, and describes the shell in such a manner that it is evident he never saw an interior of a Coal-measure shell, and that he took his type from Jurassic specimens. The figure of *Cardinia robusta* is remarkable, and has apparently been drawn from Sowerby's type, which, however, is incomplete, so that the lines of growth terminate abruptly; but in the Belgian form the lines of growth are carefully curved upwards to end, as if naturally, in the posterior slope.

This form is not mentioned by any Continental author by name, and is only figured by Achepol under a different title,[2] and in that case is found in a different coal-field. De Koninck's figure of *Cardinia carbonaria* is very different from *Unio carbonarius*, Bronn, to which it is referred.

1843. Colonel Portlock, in his 'Geological Report on Londonderry,' p. 568, mentions a shell described as Unio? figured pl. xxxviii, fig. 6, as a doubtful shell with a deep impression near the beak. It is, however, associated with marine shells,

[1] 'Neues Jahrbuch f. Min.,' &c., 1864, p. 654; see also 'Report British Association' (for 1887), 1888, pp. 68 and 69, where Ludwig's Permian *Cyclas nana* (1861) and de Koninck's Upper Carboniferous *Cardinia nana* (1842), which are distinct forms, are referred to the genus *Estheria*.

[2] Vide *infra*.

and probably belongs to the genus *Sanguinolites,* though it has somewhat the shape of *Anthracomya.*

1843. Morris[1] gives in his 'Catalogue of British Fossils,' 1st edition, 1843, under *Unio*, some of the shells described in Prestwich's memoir, *U. ? aquilinus*, *U. ? centralis, U. ? dolobratus*, *U. ? modiolaris*, and *U. ? Urii;* under the name *Cardinia*, *U. acutus*, *U. subconstrictus*, *U. ovalis*, *U. phaseolus*, and *U. robustus;* under *Modiola*, Sowerby and Prestwich's *Modiola carinata;* under *Mytilus*, Fleming's *Myalina crassa*, Sowerby and Prestwich's *Mytilus triangularis ;* under *Avicula*, the same authors' *Avicula quadrata* and *A. modiolaris.*

1843–46–55–64–67. H. B. Geinitz, in 1843, in 'Gaea von Sachsen,' p. 66, gives the forms *Mya minuta*, *Unio carbonarius*, *Unio uniformis*, the last of which, in 1846 ('Grundriss,' &c., p. 443, pl. xvii, figs. 16, 17), Geinitz re-described as *Cardinia Goldfussiana*, probably because Goldfuss had not noted the fact that Sowerby's shell *Unio uniformis* was from Oolite beds; and again in 1855 ('Die Versteinerungen der Steinkohlen-formation in Sachsen' he gives a list of synonyms and references to date, and re-describes the species.

He describes in 1855 *Unio tellinarius*, of which he says, "The posterior part of this shell is very variable—in fact, I never saw such a specimen as Goldfuss figures. Mine resemble more closely the second form figured by de Koninck, and when flattened, *Cardinia phaseolus*." A new form, *Cardinia Freystenii*, pl. xxxv, fig. 7 *a*, A, here figured and described for the first time, appears to be a short truncate *Anthracomya.*

A very important paper by this author appeared in 1864 in 'Neues Jahrbuch,' &c., p. 651, which will be alluded to in detail further on, as it is a criticism on a work which had appeared just previously.

In 1867, in the 'Neues Jahrbuch f. Min.,' &c., p. 682, Prof. Geinitz figured and described *Anthracosia Weissiana* from the Saarbruck Coal-field. I have been able to examine, by the kindness of Prof. Geinitz at Dresden, the type specimen, which consists of impressions in a micaceous sandstone. The shell is probably

[1] In Morris's 'Cat. Brit. Foss.,' 2nd edit., 1854,

Under *Unio*—	Under *Myalina*—
Unio ? *aquilinus*, Sow.	*Myalina carinata*, Sow.
„ ? *centralis*, Sow.	„ *quadrata*, Sow.
„ ? *dolabratus*, Sow.	Under *Mytilus*—
„ ? *modiolaris*, Sow.	*Mytilus crassus*, Fleming.
„ ? *parallelus*, Sow.	„ *triangularis*, Sow.
„ ? *Urii*, Fleming.	Under *Avicula*—
Under *Myacites*—	*Avicula modiolaris*, Sow.
Myacites Ansticei, Sow.	„ *modioliformis*, Brown.

At p. 189, under *Cardinia*, those forms described as such in the previous edition are repeated; and in addition, under *Cardinia* (*Pachyodon*), all those described by Capt. Brown in the 'Ann. Mag. Nat. Hist.,' 1843 (see next page).

Anthracomya Williamsoni; but I have no doubt at all as to the genus, as there are portions showing casts of the hinge-line and posterior end. The peculiar wrinkling of the periostracum, so frequently seen in *Anthracomya*, is well shown in one specimen on the slab.

1843. In the 'Annals and Magazine of Natural History,' vol. xii, p. 390, 1843, Captain T. Brown figured and described under Stutchbury's name *Pachyodon*, as new, twenty-six forms from English and Scotch Coal-measures:

Pachyodon Gerardii.	*Pachyodon Smithii.*
,, *lateralis.*	,, *Embletoni.*
,, *sulcatus.*	,, *Heyii.*
,, *rugosus.*	,, *agrestis.*
,, *subrotundus.*	,, *similis.*
,, *bipennis.*	,, *turgidus.*
,, *Dawsoni.*	,, *nucleus.*
,, *nanus.*	,, *Blaydsii.*
,, *Rhindii.*	,, *Aldamii.*
,, *amygdalus.*	,, *antiquus.*
,, *exoletus.*	,, *transversus.*
,, *dubius.*	,, *Levidensis.*
,, *subtriangularis.*	,, *pyramidatus.*

Of these, I think *P. Gerardii* and *P. pyramidatus* may have belonged to *Schizodus;* and, owing to the fact that Captain Brown did not recognise the extent of variation of which this form of genus was capable of assuming, many of these names must be considered as synonymous; but, nevertheless, several well-marked species and varietal forms are in this paper figured and described for the first time: unfortunately the descriptions are meagre, and the original specimens cannot be traced.

1844. It was in 1844 that W. King proposed the name "*Anthracosia* for a group of Unionidæ characteristic of the Coal-measures" ('Annals and Mag. Nat. Hist.,' ser. 1, vol. xiv, p. 313, 1844), which he says he intended to describe in his 'Monograph of the Permian Fossils;' but nothing further is said by King on the subject[1] save the sentence quoted.

1844. In the same year and volume, p. 100, is an interesting and valuable paper by Mr. H. E. Strickland on the genus *Cardinia.* He points out that in 'Études critiques sur les Mollusques fossiles,' Agassiz, the author of the term, seems to regard *Cardinia* as exclusively confined to the Lias and Lower Oolite, and justly criticises de Koninck for classifying "these Coal-measure shells as *Cardinia*, and prefixing a definition of the genus, which seems to be chiefly copied from de Christol's definition of *Sinemuria;* and we may, therefore, conclude that de Koninck had not been able to examine the interior of the fossils which he

[1] Until 1856, in the 'Ann. Mag. Nat. Hist.,' vide *infra*.

describes." Mr. Strickland then points out the difference in the characters of the Coal-measure shells from those of *Cardinia*, and contends for a fresh-water habitat for the former.

1844. In the same year Dr. Garner gave some drawings in the 'Natural History of the County of Stafford,' pl. E, of Coal-measure shells from the North Staffordshire coal-field; but he neither named nor described them. Figs. 21, 22, appear to be *Naiadites modiolaris;* fig. 19, *Naiadites carinata;* figs. 20 and 23, three forms of *Carbonicola.*

1845. In 1845 Murchison, von Keyserling, and de Verneuil ('Russia and the Ural Mountains,' pl. xxi, fig. 9), and de Verneuil ('Paléontologie de la Russie,' pl. xix, fig. 10), described and figured *Unio Eichwaldianus* as a Coal-measure form, closely allied to *Unio subconstrictus*, Sow., and *Unio uniformis*, Goldfuss, shells which probably belong to two different genera.

In 1846 von Keyserling, in 'Petschoraland,' &c., described *Cardinia subparallela* from Coal-measures.

1850. In a memoir with the title of 'Mélanges paléontologiques,' part 1, published in 1850, P. de Ryckholt described and figured—

Cardinia atrata, Goldfuss (not figured),	*Cardinia Scherpenzeeliana*, Ryckh.,
,, *Hullosiana*, Ryckh.,	,, *salebrosa*, Ryckh.,
,, *colliculus*, Rhyck.,	,, *macillenta*, Ryckh.,
,, *nucularis*,	*Mytilus præpes*,
,, *Toillieziana*, Ryckh.,	,, *Wesemælianus*,
,, **lians*,	,, *Toillieziana*,
,, *uncinata*	,, *Fontenoyanus*,
,, **Omaliusianus*,	,, *ligonula*,
,, **ampetilicola*,	,, *fabalis*,
,, **cordolianus*,	,, *Geinitzianus*,
,, *angulata*,	,, *divisus*,

mostly from the neighbourhood of Mons, Liége, and Tournay; but those marked thus * were from Visé. Most of the forms described as *Mytilus* are young examples of *Naiadites*, but I think it possible that *Posidonomya Gibsoni* is included amongst them.

I have been to the Museums of Brussels and Liége, but have not been able to find the original specimens, although Professor Dewalque showed me many in his own collection named after Ryckholt; and at the former place there are also specimens with his name attached. It is highly probable that many of the forms named above are synonymous, and denote different stages of growth of the same shell. The name *Mytilus præpes* is given to *Anthracomya Williamsoni* (Bronn) at Brussels. With regard to those shells described as *Cardinia*, all the forms figured belong to *Anthracomya* except *C. Hulloziana*, which is a *Carbonicola*. These *Anthracomyæ* are much embellished in the drawings, and

many of their names are synonyms, it being highly probable that many of these species are only varietal forms, or young. It is to be remarked that no mention is made by de Ryckholt of de Koninck's or any other person's previous work on the subject, save only one single specimen after Goldfuss.

1849. In 1849 Capt. T. Brown issued his 'Fossil Conchology,' in which he re-figured all those shells previously described and figured in the 'Ann. and Mag. Nat. Hist.' (*op. supra cit.*) he also gave copies of the figures of those Coal-measure forms figured and described by J. De Carle Sowerby (*op. supra cit.*), also of one form figured by Rhind, and those from the 'Mineral Conchology,' and in addition he described and figured *Unio littoralis* and *U. discrepans* from Low Moor, Bradford;

Avicula modioliformis, Water of Leith (Naiadites).
Modiola Williamsoni, Wakefield (Anthracomya), pl. lxxi, figs. 24, 25.
„ *subtruncata*, Wakefield (Naiadites), pl. lxxii, figs. 15, 16.
„ *curtata*, Wakefield (Anthracomya), pl. lxxii, figs. 19, 20.
„ *Robertsoni*, Newcastle-on-Tyne (Anthracomya), pl. lxxii, figs. 24, 25.
„ *Moorei*, Vale of Todmorden (Anthracomya), pl. lxxii, fig. 27.
„ *minuta*, Low Moor (?), pl. lxxii, fig. 29.

He drops the name *Pachyodon*, and returns to the old name *Unio*.

1851. J. W. Binney ('Manchester Lit. Phil. Soc. Trans.,' vol. x, p. 181, pl. i, figs. 1, 2; pl. ii, fig. 1) published a paper on some trails and holes found in Carboniferous strata which he thought might be due to molluscs, probably *Modiolæ*, from the shape of their casts.

1852. F. A. Quenstedt, referring in his 'Petrefactenkunde' to Coal-measure Unios, describes a "glatter Leiste unter der Ligament." (He figures *Anodonta lettica*, Quenstedt, pl. xliv, fig. 16, from the Lettenkohle of Gaildorf, which from its shape would appear to be *Naiadites*.)

1853. Isaac Lea, in his paper "On some New Fossil Molluscs in the Carboniferous Slates of the Anthracite Seams of the Wilksbarre Coal-formations," published in the 'Journal of the Academy of Natural Science of Philadelphia,' ser. 2, vol. ii, pt. 3, January, 1853, p. 203, pl. xx, figs. 1 and 2, describes and figures two new species of *Modiola*. *M. Wyomingensis* and *M. minor*, which occur with shells, which he provisionally places under *Posidonia*, and certain fish remains. *M. Wyomingensis* has apparently all the external characteristics of *Naiadites*, and, indeed, Lea compares his shell with *Modiola* (*Naiadites*) *carinata*, Sow. The figure of *M. minor* is that of a shell too fragmentary for comparison.

1854 and 1856. In 1854 McCoy ('British Palæozoic Fossils,' by A. Sedgwick and F. McCoy, p. 514) proposed the name *Carbonicola* for the Coal-measure Unios. Referring to King's proposed name *Anthracosia*, but supposing that King had given up his intention to make use of it (as he had not published anything further) McCoy gave a description.

1856. This description King pointed out, in a note (dated December 27th, 1855) appended to his paper "On Anthracosia, &c.,"[1] could not be accepted for his shell. He said, "A few days ago (December 22nd) I received from Professor Sedgwick, for the library of Queen's College, Galway, the Third Fasciculus of his 'Synopsis of the Classification of British Palæozoic Rocks,' in which I perceive that Professor McCoy has published a genus under the name *Carbonicola.* My friend evidently thinks it synonymous with *Anthracosia*, which he admits being aware that I intended describing. However, if the genus *Carbonicola* possess the characters diagnosed by Professor McCoy, it is clearly not the same as my *Anthracosia*, which does not possess lateral teeth. There are certain errors in the remarks under the genus *Carbonicola*, which it must be obvious to anyone that I am not called upon to correct; but it is otherwise with several interspersed through the work," &c., December 27th, 1855.

It is a curious fact that amongst the many hundreds of shells I have seen and examined from British and foreign Coal-measures none possess anterior or posterior lateral hinge-teeth, nor is there any specimen in the Woodwardian Museum at Cambridge, where Professor McCoy obtained his types, which answers to his description. I can altogether bear out Professor King's contention that, whatever the shell which Professor McCoy thought he was describing may have been, it could not have been an interior of one of the Coal-measure bivalves. Was he drawing from his knowledge of recent Unios, and, like Sowerby, de Koninck and later on Salter, stating what he thought probably would be seen if he obtained an interior?

Professor McCoy enumerated under his genus *Carbonicola* the following species:

Carbonicola acuta.	*Carbonicola subconstricta*, var. *robusta.*
,, *subconstricta.*	,, *turgida*, Brown.

He gave reasons for considering *C. robusta* as only a variety of *subconstricta.*

Professor King in his paper (*supra cit.*) gives a good description of the generic characters of *Anthracosia*, and shows reasons for considering that it belongs to the family *Unionidæ.* He gives figures of the hinges of *Anthracosia Beaniana*, and the exteriors of *Anthracosia acuta*, Sow., and *Anthracosia Smithii*, Brown.

The description of the hinge and teeth, as given by Professor King, is rather complex, and is the form of hinge which the species *Anthracosia aquilina* possesses. I shall, I think, show that King's *A. Beaniana* is one of the varietal forms of *A. aquilina.*

[1] 'Ann. Mag. Nat. Hist.,' ser. 2, vol. xviii, January, 1856, pp. 51—57, pl. iv.

1856. S. P. Woodward in his 'Manual of the Mollusca' placed the forms now known as *Carbonicola* under *Anthracosia* (King) as a subgenus of *Cardinia* (p. 470). He says these shells are associated with Nautili, Discinæ, &c., but gives no locality in which this association occurs.

In the reprint 1880 there is an appendix by Ralph Tate, in which (p. 71) *Anthracosia* and *Carbonicola* are placed as two distinct genera of the Unionidæ; he follows King and McCoy in the diagnosis of each genus. At p. 69 *Anthracoptera* is placed under the Mytilidæ, and at p. 80 *Anthracomya* is placed under the Myacidæ, Salter's description being followed in the two latter genera.

1855–9. In 1855 to 1859, d'Eichwald, in the 'Lethæa Rossica,' described and figured—

Modiolopsis conspicua.	*Cypricardia pumila.*
,, *tenuissima.*	*Modiolopsis Teplofi*, Verneuil.
,, *tenera.*	*Cardinia Eichwaldiana.*

All of these, except the last, from their shape appear to be *Anthracomyæ.*

On March 8th, 1858, Messrs. F. B. Shumard and G. C. Swallow read a paper, "Descriptions of New Fossils from the Coal-measures of Missouri and Kansas," published in 1858 in the 'Transactions of the Academy of Science of St. Louis,' vol. i, p. 198, in which are described *Mytilus Ottawaensis*, *Mytilus tenuiradiatus*, *Myalina Kansasensis*, and *Myalina recta* from the Coal-measures which agree very closely in character with *Naiadites.* Mention is also made in the list, p. 177, of *Myalina subquadrata* from Permian and Coal-measure beds of the Valley of Verdigris. I am unable to find the description, but the shell is, however, figured by Messrs. Meek and Hayden on p. 33 ot their 'Palæontology of Upper Missouri,' in which is also figured aud described *M. aviculoides*, pt. 1, pl. ii, figs. 8 *a*—8 *d.*

1859–64. In 1859 R. Ludwig published in the 'Palæontographica,' Band viii, pp. 33—38, "Die Najaden der Rheinisch-Westphälischen Steinkohlenformation," in which he figures and describes from that coal-field—

Unio securiformis.	*Anodonta procera.*
,, *obtusus.*	,, *minima.*
,, *cymbæformis.*	*Cyrena (Cyclas) rostrata.*
Anodonta lucida.	,, ,, *anthracina.*
,, *Hardensteinensis.*	,, ,, *extenta.*
,, *brevis.*	*Dreissina laciniosa.*
,, *cicatricosa.*	

In 1861, in another paper entitled "Süsswasserbewohner aus der Westphälischen Steinkohlenformation" ('Palæontographica,' Band viii, p. 182), he describes and figures—

Unio Lottneri.	*Unio angulatus,* Ryckholt.
„ *crassidens.*	*Cyclas elegans.*
„ *batilliformis.*	*Dreissina Feldmanni.*
„ *Geinitzi.*	„ *dilatata.*
„ *atratus,* Goldfuss.	„ *inflata.*

In 1861 ('Palæontographica,' vol. x, pp. 21 and 22), in his memoir on the fresh-water shells of the (Permian ?) Coal-formation of the Ural, Ludwig figures and describes *Anodonta* (*Anthracomya ?*) *Uralica* and *A. ? obstipa.*

In 1863, in another paper entitled "Die Paläontologie des Urals" ('Palæontographica,' Band x, p. 18, &c.), he mentions—

Unio tellinarius, Goldf.	*Anodonta Eichwaldiana,* Murchison, Keyserling, and Verneuil.
„ *Goldfussianus,* Koninck.	„ *tenera,* Eichwald.
„ *Thuringensis,* Ludwig.	„ *Uralica,* Ludwig.
Anodonta carbonaria, Koninck.	„ *obstipa,* Ludwig.
„ *ovalis,* Martin.	*Cyclas obuncula,* Ludwig.
„ *angulata,* Rhyckholt.	*Unio lepidus,* Ludwig.
„ *subparallela,* Keyserling.	

Again, in 1863–4, this author published a paper in the 'Palæontographica,' vol. xi, pp. 166, &c., on *Unio pachyodon* and three other species from various formations; *Unio Kirnensis* (being a form from the Coal-measures near Kirn, which he says is very like *U. Goldfussianus*), *U. compressus*, and *U. fabæformis* from the Rothliegenden of Neurode. So that this author is responsible for twenty-three forms of *Unio* and four forms of *Dreissina* from the Coal-measures.

The genera *Unio*, *Anodonta*, *Cyrena*, and *Cyclas* may all be here considered as synonymous with *Carbonicola*, and the author gives no reasons for this subdivision of the genera.

The majority of the originals of these figures are in the Geological Museum at Dresden, and I was permitted by the kindness of Professor Geinitz to study them there. I will first quote Professor Geinitz on the subject of Ludwig's papers, which criticism appeared in 1864 as an addendum to a paper by Gümbel (to be quoted later on in its chronological order) in the 'Neues Jahrbuch f. Min.,' &c., 1854, p. 651, where he says, "On the whole, my conclusions upon the species of Unio and Anodonta from the Coal-measures and Dyas, which Ludwig has so carefully described, differ considerably from those of that learned author;" and he proceeds to show that many of the forms are the same. The chief thing to be noticed on comparing the originals with the drawings is the amount of invention and artistic embellishment which have made crushed and damaged specimens appear as perfect. In one case the fossil itself is invented, being only a concretionary mass (*Dreissina inflata*, 'Palæontographica,' Bd. viii, t. lxxi, fig. 10). Many of the different

forms assumed by the shells are the result of crushing or imperfection, and the general accuracy of the work may be judged from Taf. v, fig. 8, where the impression of the external surface of a shell is correctly shown by the lines of growth; but the learned author has invented the anterior and posterior muscle-scars on the outer surface of the shell, and found there the accessory adductor scar wanting throughout the genus, and has described them in the text. Further, certain swellings and prominences are said to be enlargements for the ovary, and characteristic of the female sex. In the figure showing the hinge-plate of *Unio crassidens* the greater part is drawn from the imagination; for the original specimen consists of two valves which have slipped on each other somewhat at the posterior end, and shows only the posterior half of the hinge-line. I have been unable to see the lateral anterior and posterior teeth described in the text and figured, but this point will be discussed in detail hereafter.

The total neglect (in three papers out of four) of all the work done on the subject, both on the Continent and in England, is to be regretted; as, from a careful comparison of the shells, I have no doubt that the species are to a large extent the same as those previously described and figured by others.

The following papers will not be all found in strict chronological order, for in many cases there are several papers on the subject by the same author, and in this case it has been thought better to group them together, so that each writer's views may be presented in as concise a form as possible.

1860. In the Geological Survey Memoir to Sheet 142, parts of the Counties of Clare, Limerick, and Kerry, on p. 13 is a note by Mr. W. H. Baily in which is a figure (fig. 4) of *Myalina Foynesiana* from the Coal-measures of Foynes Island, co. Limerick. The specimen occurs in black shale with a Goniatite, and several specimens of *Posidonomya.* The original specimen is in the Geological Survey Collection at Dublin. In a note in the Memoir explanatory of Sheet 137, p. 12, Mr. Baily says, "At Bilboa colliery in the four-feet bed of shale immediately over coal No. 3 (three feet, or old colliery coal), which contained but few plants, fresh-water or estuarine shells (*Myacites*) allied to *Unio*, having both valves united, were found in great abundance; . . . with these were other species of bivalves, having the shells compressed, belonging to the same genus and to *Myalina.*

1860–78. The publication of the 'Acadian Geology' in 1860 by Sir William Dawson is important, as the name *Naiadites* is there given in the Supplementary Chapter to embrace all those Coal-measure shells called Unio, Anodon, Modiola, &c., by various authors. He describes eight species, six of which are figured. In the second edition, 1868, and third edition, 1878, p. 204, the shells are again figured and described with Salter's names given in brackets, the author advancing good reasons for not accepting Salter's misnomer *Anthracomya.*

Naiadites (Anthracoptera) carbonaria, Dawson.
„ „ *lævis*, Dawson.
„ *(Anthracomya) elongata*, Dawson.
„ *arenacea*, Dawson.

Naiadites ovalis, Dawson.
„ *angulata*, Dawson.
„ *obtusa*, Dawson.
Anthracosia Bradorica, Dawson (p. 314).

I have, by the kindness of Sir W. J. Dawson, been allowed to examine a series of his specimens, and the result appeared in a joint paper before the Geological Society of London (read February 21st, 1894), 'Quart. Journ. Geol. Soc.,' vol. L, pp. 435—442, 1894.

1861. In 1861 appeared the first edition of Hull's 'Coal-fields of Great Britain,' which contained one plate, of which fig. 1 is said to be *Anthracosia robusta;* and in a very brief reference to the Mollusca, pp. 40 and 43, under the names *Anthracosia* (*Unio* of early authors) and *Modiola*, a few words are said as to the marine or brackish water habitat of these forms.

In later editions, 1873 and 1881, the original plate was done away with and a new one (to face p. 38) given, with *Anthracomya carinata* (*sic*, for *Anthracoptera carinata*), *Anthracosia centralis*, and *A. aquilina.*

Prof. Hull's views as to the habitat of these shells appears to have somewhat changed; he says, "*Anthracosia* (*Unio*), *Anthracomya*, and *Anthracoptera*, capable apparently of living in fresh-water lakes or brackish water estuaries."

A very valuable paper by the same author, bearing very little on the shells themselves, from which I have quoted freely above (pp. 2, 3), appeared in the 'Quart. Journ. Geol. Soc.,' vol. xxxiii, 1877, p. 613, &c., "On the Classification of the Carboniferous Series;" but I doubt whether any evidence which he has adduced on the strength of the shells in question is of much value, owing to the great confusion which has existed up to the present time with various authors as to the generic characters of the various forms.

1856–63. The first memoir of Mr. Salter which I can find on this subject, to which he paid some attention, appeared in 1860 as the "Memoir of the Geological Survey," 'The Iron Ores of Great Britain,' Part I, 1856. 'The Iron Ores of the North and North Midland Counties' contains only the casual remark that certain beds at Chesterfield ("dog-tooth rake") "are almost made up of fossil bivalves (*Anthracosia*)," which he refers to *Unio agrestis* of Brown. He says that the "Wallis rake" at Codnor Park, Butterley, is full of the same shell.

1861. In Part III, 'The Iron Ores of South Wales,' in 1861, he enters more fully into the subject, and gives the diagnosis of his new genus *Anthracomya*, describing and figuring—

Anthracomya Adamsii.
„ *pumila.*

Anthracomya subcentralis.
„ *senex.*

He figures also—

Anthracomya modiolaris.	*Anthracosia acuta.*
Myalina quadrata.	,, *aquilina.*
,, *modiolaris.*	,, *ovalis.*
,, *carinata.*	

He discusses at some length the salt or fresh-water habitat of these groups, and endeavours to demonstrate that the *Anthracosia* were allied to the Myacidæ, and were burrowers.

1862. The next year he published in the Appendix to the 'Geological Survey Memoir,' "The Geology of the Country round Wigan," 2nd edition, a figure of *Anthracosia robusta*, showing the hinge, and the diagnosis, with diagrammatic figure, of his new genus *Anthracoptera*, the *Myalina* of his previous memoir. The description is curious, because he affirms the existence of "an obscure tooth in the anterior part of the hinge-line," and founds his genus to include those aviculoid shells "which have not the striated hinge-plate of Myalina," a character which I have shown[1] they have. He apparently made a species (*A. Browniana*) by dotting in a characteristic outline to the figure of another shell. In the same year, in the Appendix to Part IV of the 'Iron Ores,' he gives lists of the twelve mollusca of the North Staffordshire Coal-field, and the horizons at which they occur, on the authority of Mr. John Ward, F.G.S., of Longton; and in 1864, in the Appendix to the 'Geological Survey Memoir: the Country round Oldham,' he gives lists and horizons of Unio forms from the Lancashire Coal-field. Later on, in his list of fossils in 'The Country round Bolton,' he mentions a new form, *Anthracomya sanguinolaria*, MS.; but there has been no other reference made to it, and it is impossible to ascertain now what was the particular form for which the name was intended. Mr. Salter gives also numerous other lists in subsequent Geological Survey Memoirs, but does not give in them any further contributions of importance to the subject.

1863. In 1863, however, in a paper "On some Fossil Crustacea from the Coal-measures and Devonian Rocks of British North America," in the 'Quart. Journ. Geol. Soc.,' vol. xix, pp. 79, 80, treating of Some Fossils from the South Joggins Coal-field, Mr. Salter figured and described *Anthracomya elongata* (fig. 1), *Anthracoptera carbonaria* (fig. 3, a different figure from that of Dawson's *Naiadites carbonaria*), and *Anthracoptera* (*Naiadites*, p. 78) *lævis* (fig. 2, and p. 80), substituting these generic names for "Naiadites" proposed by Dr. Dawson, but without description.[2]

Anthracomya elongata, p. 79, fig. 1.	*Naiadites*, Dawson, p. 80.
Naiadites lævis, p, 79, fig. 2 (*Anthracomya*, p. 80)	
Anthracoptera carbonaria, p. 79, fig. 3.	

[1] 'Quart. Journ. Geol. Soc.,' vol. xlix, 1893, pl. vii, figs. 1, 2.

[2] On February 21st, 1894, a note "On the Genus *Naiadites* occurring in the Coal-formation of

1862. Mr. Thos. Wardle, F.G.S., contributed a paper on "The Geology of the Neighbourhood of Leek" to John Sleigh's 'Ancient History of Leek,' in which he gives lists of *Anthracosia* (Carbonicola), *Anthracomya*, and *Anthracoptera* (Naiadites) which occur in the beds of the North Staffordshire Coal-field, and on pl. iv figures two specimens of *Carbonicola acuta*, fig. 13, under the name of *Anthracosia robusta*. Fig. 14, as *Anthracomya*, resembles *A. pumila*.

1862. In April of this year Mr. George Wild read his paper on "The Fulledge Section of the Burnley Coal-field' before the Manchester Geological Society, subsequently published in vol. iv, pp. 180, &c., of the 'Transactions.' He gives accurate horizons for shell-bearing beds, but only mentions the specific names of two of them, *Anthracosia robusta* and *A. acuta*.

1865. Huxley and Etheridge enumerate several species in their 'Catalogue of the Collection of Fossils in the Museum of Practical Geology,' pp. 156—161, but mention no new forms nor give any descriptive details.

1864–82. H. B. Geinitz remarks on the paper by Gümbel, "Ueber das Vorkommen von Süsswasserconchylien am Irmelsberge bei Crock am Thüringer-Wald," in the 'Neues Jahrbuch f. Min.,' &c., 1864, p. 651, on the forms—

Unio tellinarius, Gold.,	*Unio crassidens*, Ludwig,
„ *Thuringensis*, Ludwig,	„ *carbonaria*, Gold,
„ *uniformis*, Goldfuss,	„ *Goldfussiana*, de Koninck,
Anodonta phaseolina, ? Estheria,	*Anodonta ovalis*, Martin,

only inventing the doubtful form *A. phaseolina*. He criticises Ludwig's species, and considers many of the named forms as synonymous.

1882. Later again, in 1882, he published a new form from the Dyas, *Anthracosia stegocephalum* ('Nachträge zur Dyas,' Heft 2, 1882, p. 43, pl. viii, figs. 20, 21).

1865. Volpersdorf describes and figures a *Modiola*, sp., from Glatz County in beds with scales of *Rhizodus Hibberti*, in the 'Zeitschrift des Deutsch. Geol. Ges.,' vol. xvii, 1865, p. 276, pl. vi, fig. 6, which is doubtless *Anthracomya*.

1860. McChesney described *Myalina Swallovi* in his 'New Species of Palæozoic Fossils,' p. 57, issued in 1860, and with the illustrations to the same gives figures on pl. ii, figs. 6 *a*, 6 *b*: "I have not been able to obtain access to these papers, and quote the reference from Messrs. Meek and Worthen's 'Geological Survey of Illinois (Palæontology),' vol. ii, p. 341."

1860. In the 'Proceedings of the Academy of Natural Sciences of Phila-

Nova Scotia," by Sir William Dawson, was read before the Geol. Soc. London, in which he points out that some of the shells named by him *Naiadites* belong to the same genera as those subsequently named *Anthracomya* and *Anthracoptera* by Salter; and that consequently his name *Naiadites* has priority. He advances additional reasons for a fresh-water habitat of these shells. A note was appended by myself, in which I concurred in the substitution of the name *Naiadites* for *Anthracoptera*.

delphia' for 1860, p. 496, Messrs. F. B. Meek and A. H. Worthen publish a paper entitled "Descriptions of New Carboniferous Fossils from Illinois and other Western States," in which is described *Myalina recurvirostris* from the Coal-measures, Illinois.

1864. In the volume of the same Society for 1864 the same authors, on p. 246, describe *Pleurophorus subcostatus* from the Coal-measure of Illinois, which I believe to be from the description a form of *Anthracomya.*

1886. In vol. i of the 'Proceedings of the Chicago Academy of Sciences,' p. 18, is a paper by Messrs. F. B. Meek and A. H. Worthen entitled "Descriptions of Palæozoic Fossils from the Silurian, Devonian, and Carboniferous Rocks of Illinois and other Western States," in which they describe as new species *Anthracoptera ? fragilis* from the Keokuk division of the Subcarboniferous series and *Myalina meliniformis* from Coal-measures of Illinois.

1866. F. B. Meek redescribes and figures in the Report of the 'Geol. Surv. Illinois,' vol. ii, Palæontology—

Myalina concentrica, Meek and Worthen, pl. xix, figs. 3 *a*, 3 *b*, 3 *c*, p. 281.
" *angulata,* pl. xxiii, figs. 7 *a* and *b*, p. 300.
" *recurvirostris,* pl. xxvi, figs. 9 *a—c*, p. 334.
" *Swallovi,* McChesney, pl. xxvii, figs. 1 *a—d*, p. 341.
" *meliniformis,* Meek and Worthen, pl. xxvii, fig. 3, p. 343.

1868. In the 'Transactions of the Geological Society of Glasgow,' read February 8th, 1868, vol. iii, 1871, p. 96, is found a valuable paper entitled "On the Upper Coal-measures of Lanarkshire," by William Grossart, the object of which is to correlate the various beds by their fossil contents. He states, p. 102, "Of the genus *Anthracosia,* the species *A. acuta, A. aquilina, A. ovalis, A. centralis, A. phaseolus,* are found in most of the beds of Kiltongue coal, but no further. *Anthracomya modiolaris, Anthracoptera modiolaris,* and *A. carinata* prevail in most of the beds. . . . . *Anthracoptera quadrata* appears to have had a very limited range, being seldom, if at all, seen beyond the region of the Splint Coal." . . . . *Anthracosia rugosa* [evidently *robusta*] is first met with in the Drumgray Coal, all other species of the genus having now disappeared." This is the bed from which so many good specimens of *A. robusta* are obtained at Shotts. He appends the following note:—"The genus *Anthracosia* appears to be confined to the Upper Coal-measures of Lanarkshire."

In the same volume, p. 283, in a paper by Mr. Robert Craig on "The Carboniferous Basin of Dalry," mention is made of the occurrence of *Myalina crassa* at Roughwood, Lyonshield, and Broadstone.

1870. Römer described, in 1870, a little bivalve-like *Modiola* from the "Coal-group, Charlotte," near Czernitz, in the "Geologie und Paläontologie von Oberschlesien," foot-note to p. 76, and "probably identical with *Modiola,* sp.

(Volpersdorf, *op. supra cit.*). This shell occurs in the Coal-measures of Lancashire.

1870. In the 'Geological Magazine' for 1870 is a paper by Professor Rupert Jones on some "Entomostraca from the Coal-measures of South Wales." At p. 216 he notices some *Anthracomyæ* from the Ebbw Valley, and refers to the compressed *Anthracomyæ* in the Ardwick beds described by Phillips (*op. supra cit.*), and figures (figs. 3 and 18, pl. ix) are given.

1891. This author also refers generally to the Coal-measure bivalves in his Address to the Geological Section of the British Association at Cardiff, in 1891. At p. 17 he remarks, "There is great probability of these not being truly marine. They may have lived in the brackish waters of lagoons and creeks, in the black, muddy swamps, having some communication with the sea, and often or occasionally inundated with salt water."

1871. Messrs. Young and Armstrong brought out their work 'On the Carboniferous Fossils of the West of Scotland, for the Use of the British Association Meeting at Glasgow, 1871.' They give lists and localities, but describe no new forms. Their views as to the fresh-water habitat of the shells I have quoted above (p. 4).

1871. In 1871 Ferd. Stoliczka, in 'Palæontologica Indica,' vol. viii, p. 84, places *Anthracosia* under *Saxicava*, and writes, "Prof. King advocates the idea that *Anthracosia* is a genus of Unionidæ, but there can be little doubt as to its close relation to *Notomya*, and it is even difficult to distinguish some of the species generically. The ligamental area of *Anthracosia* much more recalls that of *Panopæa* and *Cyrtodaria* than that of any known Unionidæ, and as Salter distinctly asserts that it is a marine or brackish water shell, I think its classification in this place (*Saxicava*) may be the more correct one."

1873. The work was carried on in Scotland by Mr. Robert Etheridge, jun., his first paper on the subject appearing in the Appendix to the 'Memoirs of the Geological Survey of Scotland: Explanation of Sheet 23.' Here a stratigraphical list of the localities and beds containing Coal-measure Lamellibranchs is given, and a note is appended (p. 104) on the burrowing habits and affinities of *Anthracosia;* he says, "Specimens of *A. robusta* and *A. acuta* were obtained resting on their ventral margins at right angles to the bedding of the entombing matrix; but none were obtained in a vertical position burrowing, as we find is the case with recent *Mya truncata.*"

1875. In the 'Annals and Magazine of Natural History,' series 4, vol. xv, 1875, p. 427, "Notes on Carboniferous Lamellibranchiata," he gives the bibliography of *Myalina crassa* (*Mytilus crassus* of Fleming), and discusses its generic relations, giving some excellent plates.

1877. In the 'Geological Magazine,' new series, dec. 2, vol. iv, June, 1877,

pp. 243, 244, Mr. R. Etheridge, jun., gives a bibliographical account and a full accurate description of *Anthracomya Phillipsii;* and describes and figures a new form, *Anthracomya Scotica*, which he compares with *Naiadites lævis*, Dawson (Salter), and *Unio nuciformis* of Hibbert.

1878. His next contribution to the subject was in 1878, in the 'Quart. Journ. Geol. Soc.,' vol. xxxiv, "On our Present Knowledge of the Invertebrate Fauna of the Lower Carboniferous and Calciferous Sandsone Series," read November 7th, 1877. He re-describes Salter's genus of *Anthracoptera*, and doubtfully gives a new species, *Anthracoptera* (?) *obesa* (p. 12), pl. i, figs. 12, 13, 14 (?). He also makes some additional remarks on *Myalina crassa*, and describes and figures another form as *Myalina sublamellosa*, pl. i, fig. 15; pl. ii, figs. 16, 17. A specimen, pl. ii, fig. 20, is also doubtfully referred to *Anthracosia nucleus*, Brown, and *Axinus Pentlandicus* (pars), Rhind.

1879–81. In 1879, in the Appendix to the 'Geological Survey Memoir Scotland,' Explanation of Sheet 31, full lists of localities of shells occurring in the district are given, unfortunately often without specific names; and a new form of *Anthracoptera, A. tumida* is described (without a figure) from the "Edge Coal" series, and its specific characters discussed at p. 82. Again, in 1881, in his Address delivered before the Royal Physical Society of Edinburgh, on "The Palæozoic Conchology of Scotland," pp. 48, 50, and 53, the generic affinities and the habitats of the genera *Anthracoptera* (Naiadites), *Anthracomya*, and *Anthracosia* (Carbonicola) are discussed. He sums up, "*Anthracosia* was probably not a purely fresh-water genus, but of brackish water habit."

1875. In a valuable paper on the "Organic Remains of the Coal-measures of North Staffordshire," published in the 'Proceedings of the North Staffordshire Field Club and Archæological Society,' 1875, p. 184, Mr. John Ward, F.G.S., gives a list of the *Anthracosiæ*, *Anthracomyæ*, and *Anthracopteræ*, and a record of the horizons at which they occur. He describes no new forms, and figures none of the shells, but gives full references to his authorities. The paper contains a short discussion on the vexed question of habitat; and he believes he has found *Anthracosia* in the vertical position in the "Cockshead Shale."

A fuller account appeared in his monograph, "Geology of the North Staffordshire Coal-field, 'Trans. N. Staff. Institute of Mining and Mechanical Engineers,' vol. x, part v, issued in 1890, and pl. i contains figures of—

Anthracosia robusta.
" *acuta* (a fine interior).
" *centralis ?.*
" *aquilina ?.*
Anthracomya Adamsii.
" *Adamsii* (allied to *A. modiolaris*).
Anthracomya modiolaris (*Anthracoptera*).
" *carinata* (*Anthracoptera*).
Modiola lithodomoides, on the authority of R. Etheridge, sen. (*Anthracomya lanceolata*, Hind).

The notes of interrogation and remarks are my own, from a personal examination of the specimens figured.

One new form, "*Anthracomya Wardi*," is described by R. Etheridge, sen., as if that genus belonged to the *Myacidæ*. In the text which deals with the stratigraphy of the coal-field, the beds in which the various forms occur are carefully noted.

1878. Mr. G. H. Kinahan, M.R.I.A., gives in his 'Geology of Ireland' a plate (pl. iv) with two forms of Coal-measure bivalves from Bilboa, Queen's Co., which he names *Myacites fabæformis* and *Anthracosia Bilboensis*. I have seen examples of the latter in the Royal Museum, Dresden, which were collected from Bilboa by Dr. Geinitz, and which I recognise as *Anthracomya Williamsoni* (Brown).[1]

He quotes Mr. Baily as to the occurrence of bivalve mollusca in the various Irish coal-fields.

1880. In 1880 Dr. John Young read, January 13th, a paper, subsequently published in the 'Transactions of the Geological Society of Glasgow,' vol. vi, p. 223, for that year, entitled "Notes on some Carboniferous Lamellibranchs." He discusses and sums up in favour of the fresh-water habitat of the genera *Anthracoptera*, *Anthracomya*, and *Anthracosia*. He there chronicles his discovery of prismatic cellular structure in the shells of *Anthracoptera* (*Naiadites*).

1880. In the 'Palæontographica,' vol. xxvii, p. 109, is a paper by Dr. Hans Polig, under the curious title "Maritime Unionen." In this he advances the view that the *Anthracosiæ* of the Coal-measures, the *Unios* of the Triassic, and the *Cardiniæ* of the Jurassic form a natural group, connecting on the one hand the *Cyprinidæ*, and on the other *Najades*.

1880–83. 'The Niederrheinisch Westfällisch Steinkohlen-Gebirge Atlas' was published by Achepol during the years 1880 to 1883. This remarkable work is distinguished by having, instead of plates, photographs of the objects themselves. These photographs are often so imperfect, from bad arrangement of the light during the process of photography, and the objects themselves are so often fragmentary and indistinct, that little or nothing can be made out of them. Added to this, the inventive genius of the author as to species-making is excessive, and he describes and figures thirty-seven forms, thirty-two of which are said to be new, although he has adopted names which previous authors had given to different forms.

Anthracosia Goldfussi, Achepol.	*Anthracomya Williamsoni*.
,, *tellinaria*.	
,, *securiformis*, Ludwig.	

[1] Since going to press I have by the courtesy of the Officers of the Geological Survey of Ireland been permitted to examine the specimens in the Dublin Museum. I consider that the forms labelled there as above are both of them *Anthracomya* closely allied to *A. Williamsoni*.

Conocardium fusiforme, Achepol.	Not to be recognised.
,, *elegans*, Achepol.	Evidently *Naiadites*.
Anthracosia Beyrichi, Achepol.	*Carbonicola aquilina*.
Terebratula planosulcata, Achepol.	*Naiadites ?* said to have umbones.
Anthracosia gracilis, Achepol.	Photography and figures too poor.
,, *caudata*, Achepol.	
,, *minor*, Achepol.	
,, *Schlüteri*, Achepol.	*C. acuta* in Supplement.
,, *batilliformis*, Lud.	
,, *Decheni*, Achepol.	*C. aquilina*.
,, *Serloi*, Achepol.	
,, *rectangularis*, Achepol.	*C. acuta*.
,, *Hauchecornei*, Achepol.	*C. aquilina*.
,, species ? Achepol.	Too fragmentary.
,, *minima*, Achepol.	
,, *Berendti*, Achepol.	*C. aquilina*.
,, *Fabricii*, Achepol.	*C. acuta*.
,, *Römeri*, Achepol.	*C. aquilina*.
,, *Harzii*, Achepol.	*Anthracomya*.
,, *crassa*, Achepol.	*Carbonicola robusta*.
,, *naviformis*, Achepol.	*Anthracomya ?*
,, *obtusa*, Achepol.	Not Ludwig.
,, *brevis*, Achepol.	*Anthracomya ?*
,, *cassiformis*, Achepol.	*C. turgida*.
,, *concentrica*, Achepol.	*C. aquilina*.
,, *conocardium*, Achepol.	*Carbonicola*, crushed.
,, *Geinitzi*, Lud.	*C. aquilina*.
,, *Lottneri*, Lud.	
Anthracosia ovalis, Achepol.	
Mytilus eduliformis, Achepol.	*Naiadites carinata*.
Anodonta angulata, Achepol.	*Anthracomya*.
Dreissena Römeri, Achepol.	*Naiadites carinata*.
,, *Schlüteri*, Achepol.	

The figures of specimens described as *Dreissina*, *Mytilus*, *Terebratula*, and *Conocardium* are evidently those of *Naiadites*. The figures given in the four supplemental plates are better, but no reference is given in these to the specimens. Looking critically through these plates, I can find little or nothing new.

The specimens figured as *A. Goldfussi*, *A. naviformis*, *A. brevis*, *A. Harzii*, and *Anodonta angulata* are evidently *Anthracomyæ*.

The real merit of the work lies in the careful record of the fossils (plants and mollusca) which each bed contains; and it is a great pity that more care was not taken to compare the shells with the superabundant forms already named. I have given by the side of the list the proper equivalents, as far as I can judge from the figures and descriptions.

1881. Mr. W. H. Baily, in the "Explanatory Memoir of the Geology of the Leinster Coal-fields," 'Geological Survey of Ireland,' 1881, on pp. 21 and 25 notes the occurrence of *Anthracosia Bilboensis* and *Myacites fabæformis*[1] in the Lower and Middle Coal-measures of and around Castlecomer.

1881. Professor A. von Koenen, of Göttingen, has an important paper[2] in the 'Zeitsch. Deutschen Geolog. Gesellsch.,' vol. xxxiii, 1881, p. 680, pl. xxvi, figs. 6, 7, in which he re-describes the hinge of *Anthracosia securiformis*, and points out that Ludwig overlooked the fact that the supernumerary muscle-scar is close to the hinge-line, and on this fact bases his view that the *Anthracosiæ* are related to *Cardiniæ*. With regard to a lateral tooth he says, "Als Seitenzahn deutbar eine stumppe Kante auf dem Schossrande der linken Klappe und in der rechten eine flache Furche vorhanden." His figures are typical of the hinge of *Carbonicola aquilina*, and agree well with King's figures (*op. supra cit.*).

1882. The 'Recherches sur les Terrains anciens des Asturies et de la Galice' of Dr. C. Barrois appeared in 1882. He refers to Coal-measure shells at pp. 334 and 335. He makes the pertinent observation that the forms referred to *Myalina* by Meek and Worthen (*op. supra cit.*) cannot be separated from Salter's *Anthracoptera*, and describes and figures *Myalina carinata* and *M. triangularis*; but does not recognise the fact that these forms have not the true myophores of *Myalina*.

He figures and describes a shell which he refers to *Pachyodon bipennis*, Brown; but his figure appears too angular to agree with the original drawing. There is also one new form described, at p. 343, as *Naiadites Tarini*, the figure of which (pl. xvii, fig. 14) is exceedingly like the shell I figured ('Quart. Journ. Geol. Soc.,' 1893, pl. x, fig. 13) as *Anthracomya lanceolata*. It is probable that the two shells may be of the same species.

1882. In the same year Dr. J. R. S. Hunter, of Braidwood, produced his paper ('Trans. Geol. Soc. of Glasgow,' March, 1882, vol. vii, p. 143, &c.) "On the Geology and Palæontology of Banhead, Bellfield, Coalburn, and Lesmahagow," with lists of fossils. He enumerates from the Middle Coal-measures (p. 150)—

Anthracoptera carinata.	*Anthracoptera quadrata.*
,, *modiolaris.*	*Anthracosia acuta.*

1888. The following British forms of *Anthracomya*, *Anthracosia*, and *Anthracoptera* are enumerated in Etheridge's 'Catalogue of Palæozoic Fossils, Britain,' 1888, p. 278, &c.:

[1] There is a misprint in the original, p. 25, of *fabæforonis* for *fabæformis*.

[2] "Ueber die Gattung *Anoplophora*, Sandberger (*Uniona*, Pohlig)."

Myadæ.

Anthracomya Adamsii.	*Anthracomya pumila.*
,, *dolobrata.*	,, *rugulosa.*
,, *modiolaris.*	,, *sanguinolaria.*
,, *Phillipsii.*	,, *Scotica.*
,, *subcentralis.*	,, *senex.*
,, sp. (Phillips).	

Unionidæ.

Anthracosia acuta.	*Anthracosia ovalis.*
,, *aquilina.*	,, *phaseolus.*
,, *centralis.*	,, *robusta.*
,, *lateralis.*	,, *subconstricta.*
,, *nuciformis.*	,, *turgida.*
,, *nucleus.*	,, *Urei.*

Mytilidæ.

Anthracoptera Browniana.	*Anthracoptera quadrata.*
,, *carinata.*	,, sp. (Salter).
,, *modiolaris.*	,, *tumida.*
,, *obesa.*	

1890. Mr. Charles Roeder, in "Notes on the Upper Coal-measures of Slade Lane, Burnage" ('Manchester Geol. Soc. Trans,' vol. xxi, p. 114, read December, 1890), gives a full description of these beds, many of which contain mollusca. With one or two exceptions, however, he gives no specific names.

1892. In the same volume (vol. xxi, p. 364, read December 8th, 1891) is a paper by Mr. George Wild, on "The Lower Coal-measures of Lancashire," of great value. He figures (pl. ii, fig. 7) a new angular species of *Anthracosia*, which turns out, however, to be *Schizodus carbonarius.*

He also mentions in his Catalogue at the end of his paper, *Anthracosia*, sp., like *Sanguinolites*, from the Mountain-mine roof, Shaw, near Oldham; and *Anthracosia aquilina*, from a bed thirteen yards below the same seam at Rishton.

1892. M. X. Stainier gives (in 'Annales Soc. Géol. de Belg.,' vol. xix, p. 2) a list of shells, referred to by previous authors, from beds in Belgium, with a few additional localities from his own knowledge.

1892. In 1892 appeared the work of Professor W. Amalizky, "Ueber die Anthracosien der Permformation Russlands,"[1] in which he reviews most of the literature bearing on the generic affinity of the Unio-like forms of the Coal-measures. He erects the group into a family, under the name of *Anthracosidæ*, and divides the family into five genera:

Anthracosia, King.	Cardinal teeth only.
Carbonicola, M'Coy.	Cardinal and lateral teeth.
Najadites, Dawson.	Edentulous forms.
Palæomutela.	New multidentate forms.
Oligodon.	New multidentate forms.

[1] 'Palæontographica,' Band xxxix, 1892, p. 125, &c.

Many species of each form are described from the Permian beds of Russia, but the work will be here more fully discussed under the observations on the genus *Carbonicola*.

1893. In 1893 he published a small paper in Russ and German, "Ueber süsswasser Lamellibranchiata aus den carbonischen Bildungen des Donetz Beckens," read before the Section of Geology and Mineralogy of the St. Petersburg Natural History Society; in this he gives a plate, figs. 1 to 7, showing the hinge apparatus of *Carbonicola*, M'Coy, and figs. 10 to 17 of *Anthracosia*, King.

1893. In the 'Quart. Journ. Geol. Soc.,' May, 1893, vol. xlix, p. 249, is a paper by myself on "The Affinities of *Anthracoptera* and *Anthracomya*," in which I attempted to delineate more fully the generic characters of each, and to describe and figure the known forms. Subsequent study has necessitated some few alterations.

Another short paper of mine is to be found in the 'Annual Report of the North Staffordshire Field Naturalists' Club and Archæological Society,' which, however, contains nothing beyond what is included in the previous paper.

In the 'Geological Magazine,' dec. III, 1893, vol. x, p. 514, is a note on the so-called *Myalina crassa*, Fleming, in which I point out the identity of the anatomical characters of the shell of *Myalina crassa* with those of *Anthracoptera* (*Naiadites*).

In the same volume, p. 540, is a note (with a woodcut) on a slab from the shale above the Kinderscout Grit, showing a piece of fossil wood surrounded by numbers of *Anthracoptera* (*Naiadites*), and to which they had evidently attached themselves with the byssus.

1893. Mr. J. F. Whiteeaves published a paper on some large Unio-like shells of the South Joggins in the 'Trans. Royal Society of Canada,' Sect. IV, 1893, p. 21, in which he discusses the question of the earliest occurrence of Unio in geological strata, and describes some very large new Coal-measure fossils as *Asthenodonta Westoni*, with two figures, from which their close generic relationship to *Carbonicola* is very apparent, the hinge resembling that of *Carbonicola aquilina*, and to this genus it will probably be one day referred.

When I went to look through the collection of Coal-measure shells in the Manchester Museum, Owens College, I found that Mr. H. Bolton, F.R.S.E., Assistant Keeper, had intended to work up the subject, and had already in MS. a portion of his paper. It was at first proposed that he should join me, and that we should issue a joint Monograph; but subsequently, with great generosity, he retired and left the work to me. I have to thank him for his self-effacement in this matter, and for his further kindness in looking over my specimens, MS., and proof sheets, and for several valuable observations which have been of great service to me in the preparation of the section on *Carbonicola*.

§ III. CARBONICOLA.

It is always a difficult matter to decide as to which characters in a group of shells are to be regarded as of definite generic or specific value. Classifications, though based on anatomical resemblances, are, as Herbert Spencer states, only "subjective conceptions which have no absolute demarcations in nature corresponding to them;" so that it comes to be almost a purely personal matter to decide on what forms shall be considered for utilitarian purposes as of specific rank, or what others shall only be estimated as varieties.

I have felt that it was necessary as an aid to determine the horizons of such important beds as those of the Coal-measures to give specific rank to any forms which seemed to be typical of a bed; in other cases, when in the same beds a series of varieties occurred, to include them under one species.

The great difficulty in the subject lies in the very variable shape and characters of shells from the same beds; and were it not for the fact that I have fortunately been able in nearly every case to study hundreds of specimens, I probably should have been tempted to double the number of named forms.

A larger amount of variation might have been expected to have occurred in forms of this group obtained from the different coal-fields, but as a matter of fact the local variation is far greater. Amongst fresh-water shells there cannot exist the means for that free intermixture and consequent maintenance of a more constant type which obtains with marine mollusca. They would of necessity be isolated by drainage systems; and it is difficult to see, in the absence of aërial animals, how any amount of dispersion could take place except by floods. It is difficult to account for excessive variation in gregarious organisms with an identical environment; and this tendency to vary would appear to be universal, from the large numbers of forms that have been described and named by previous authors.

The beds in which the bivalve mollusca of the Coal-measures occur are indurated marls, black shales, and ironstones; and in most cases the fossils have both valves preserved in a closed position, showing that they are in the place and position in which they lived. They generally lie with their long axes parallel to the lines of stratification; but there exist beds in nearly every coal-field composed of the crushed valves and *débris* of myriads of shells which appear to have been finally deposited after death of the animal, the valves being nearly all single, or if double, widely opened out flat. As a rule, the lower beds of the Middle Coal-measures (stage F of Prof. Hull) are the most prolific in molluscan remains. I can find no evidence of any shells, except a compressed *Anthracomya* (*A. Phillipsii*)

above the Spirorbis Limestone. These occur in North Staffordshire, in the Blackband Ironstones. In a downward direction these shells are rarely found below the Millstone-grit, or even in these beds except in Scotland, and perhaps the north of England; and this is probably due to the fact that in England the Yoredale and Lower Limestone series (stages A, B, and C of Professor Hull) are essentially and probably wholly marine; while in Scotland and the north of England marine appear to have alternated with fresh-water conditions.

ASIPHONIDÆ (Integropalliata).

Class PELECYPODA (Lamellibranchiata).

Family UNIONIDÆ.

Genus Carbonicola, *M'Coy*, 1855.

Synonyms :

Unio, Retzius, 1788.
Mya, Martin, 1809.
Unio, Sowerby, 1829.
Pachyodon, Brown (*non* Stuchbury), 1843.
Cardinia (in part), Agassiz, 1841.
— — De Koninck, 1842.
Anthracosia, King, 1856.
— Amalizky, 1893.
Naiadites (in part), Dawson, 1860.
Carbonicola, Amalizky, 1893.

Generic Characters.—Equivalve, inequilateral, ovate or elongated, umbones convex, raised above hinge-line, sometimes eroded, generally anterior, beaks more or less contiguous, and with well-marked oval lunette in front of them. Anterior part of shell broad and tumid, posterior narrower and slightly compressed. A shallow, oblique, broad constriction, most marked at lower border, is situated a little posterior to the middle of the shell in most species. Anterior border bluntly curved, posterior narrow, truncated, curved, or angulated.

Surface marked with coarse concentric lines of growth. Periostracum thick, often wrinkled. Ligament external. Shell closed all round, nacreous, with occasionally pearly nodules. Radiating lines.

Interior:—Pallial line simple. Anterior-adductor scar large, almost marginal. Posterior-adductor scar large. Scars of the anterior-pedal muscles are situated above and slightly behind the anterior-adductor impressions.

Hinge-plate triangular, thickened, variable, with or without cardinal teeth. No anterior or posterior lateral teeth.

Observations.—Much uncertainty has existed amongst previous observers as to the true generic character of *Carbonicola*, and this doubtless arose from the paucity of specimens showing the hinge-structure, and the very variable appearance of the specific forms. The general consensus of opinion has, however, been that *Carbonicola* possessed marked Unioniform characters, and that in them we have some of the oldest representatives of this family. The chief facts in support of this view are the association of these fossils with plant and reptilian remains, and the anatomical features of the shells. The more important of these are—the shell being composed of an internal or nacreous layer, and an outer or prismatic; the thickened and wrinkled periostracum; occasional erosion of the umbones; the plan of the hinge, though it differs much in detail from that of most Unios; the simple pallial line, and the arrangement of the anterior and posterior adductor scars; the frequent possession of an oblique shallow depression, commencing at the umbo and stretching backwards and downwards to the lower border; also the general shape of the shell. The points in which *Carbonicola* differs from modern *Unionidæ* are the position of the accessory-pedal scars; the frequent non-erosion of the umbones; and the great variation of the hinge-structure in the species.

I have been compelled to drop Prof. King's name of *Anthracosia* for two reasons:—1st, that in his original publication ('Ann. Mag. Nat. Hist.,' vol. xiv, 1844, p. 313) no description or figure of the characteristic features was given; 2nd, that although M'Coy's name of *Carbonicola* is accompanied by a partially erroneous diagnosis, and unaccompanied by figures, yet there is no doubt whatever as to what shells are described under this name; neither is there any question as to priority, the publication by M'Coy of the name *Carbonicola* was at once commented on by King in a letter which I have quoted *antea*, p. 21.

The form of hinge described by Professor King is not, however, typically characteristic of the genus, but is that form which obtains only, as far as I am yet aware, in *Carbonicola aquilina*. Unfortunately the original specimens are not to be found, unless a very fragmentary example showing the hinge, in the Museum of Newcastle-on-Tyne, labelled in King's handwriting, is one of them.

I am at a loss to account for the description of the hinge as given by Professor M'Coy ('Brit. Pal. Foss.,' p. 514), where he says that it consists of "one very

thick cardinal tooth in the right valve, diverging obliquely towards the posterior side, one long anterior and one long posterior lateral tooth;" and again under *Carbonicola subconstricta* (p. 515), "Casts show the thick cardinal tooth and slender elongate lamellar lateral teeth." I have never been able to see any indications of "slender elongate lamellar lateral teeth," though I have examined hundreds of specimens; and further, I cannot see them in the types and specimens figured by Ludwig, who also describes these teeth. Professor McKenney Hughes has kindly permitted me to study all the specimens of *Carbonicola* and allied shells in the Woodwardian Museum. There are amongst these specimens only two in which the hinge-plate is visible, one of which (Pl. VI, fig. 44), a portion of the right valve, has an oblique posteriorly diverging cardinal tooth just under the umbo, with a concavity posterior to it for the corresponding tooth of the left valve; in the other (Pl. VI, fig. 43) there is a different form of cardinal tooth, but in neither can I see any indication of lateral teeth. M'Coy further, in describing the hinge-characters of the different species of *Anthracosia*, assumed that his type was invariable—an assumption which could not have been based on observation, as may be seen by the various forms of hinge figured in the plates of this Monograph. I cannot help thinking that, having settled on the Unio-relationship of this group, the typical hinge was assumed from the observation of recent forms. The specimens described in M'Coy's work were all stated to be in the Woodwardian Museum, but no specimen existing there now has the characteristics described under the name *Carbonicola*. Unfortunately, Professor Amalizky, of Warsaw, has in his work on the Permian *Anthracosiæ* retained both *Carbonicola*, M'Coy, and *Anthracosia*, King, as genera of a new family *Anthracosidæ*, relying on the hinge-characters given by these authors as diagnostic features. He admits, however, that, owing to the absence of a drawing, it is impossible to know what M'Coy really meant by "lateral teeth;" but he considers that the forms figured and described by Ludwig, and now in the Museum at Dresden, demonstrate this lateral tooth. In another place, however, he remarks, "We must not forget that the difference between these two genera [*Anthracosia* and *Carbonicola*] is only quantitative," and proceeds to show that in a series of specimens the hinge varies extremely, so that it passes from that of the form which he calls *Anthracosia* into that which he calls *Carbonicola*. I am sorry to say that I consider the descriptions and drawings of Ludwig altogether untrustworthy. I made a special visit to Dresden with a view of testing Prof. Amalizky's statements, and was allowed by the kindness of Prof. Geinitz to examine in detail the types and figured specimens there. Prof. Geinitz had already raised doubts as to the value of many of Ludwig's species, but had said nothing about the inventive genius displayed in the manufacture of artistic drawings. Ludwig seems to have described any shell which varied in the smallest particular under a new name; while

unfortunately in his earlier publications totally ignoring the work already done in the subject by English, Belgian, and other geologists. The figured specimens are, with very few exceptions, crushed, poor, incomplete, or undeveloped from the matrix—conditions which have not appeared either in the drawings or the text. Not only does he see fit to divide the genus into *Unio*, *Anodon*, and *Cyrena* (*Cyclas*) without advancing any differential diagnosis, and these genera into many species, but he invents anatomical features in the hinge, and in one case (*Anodonta cicatricosa*) indicates, in a cast left by the outer surface of the shell, the anterior and posterior adductor-muscle scars, not having recognised that the specimen showed the impression of the external surface only. In another specimen a concretion has been mistaken and figured for a specimen of his *Dreissena inflata*.

I examined many specimens, both in Berlin and Dresden, of forms similar to those described by Ludwig, and in no one was I able to satisfy myself of the presence of lateral lamellar teeth; and, moreover, I felt sure that the species were similar to those which had been described by previous writers. Still it is possible that Professor Amalizky may be wrong in considering that Ludwig meant to describe lateral teeth as being present. In the latter's description of the hinge of his *Unio securiformis* (*C. aquilina*), of which the drawings are fairly correct, is found "Das stark entwickelte Schloss besteht aus einem am Vorderende sitzenden gefalteten Zahn und einer runden, langsgefaltteen Leiste oben und nach hinten." The question here arises as to the exact interpretation to be put on the word "Leiste," as to whether it is to be taken as indicating a lateral tooth, or being used to describe the hinge-plate, such a tooth not being present in the specimen, but the posterior part of the hinge being a flattened vertical plate, somewhat irregularly rounded, surmounted by a groove for the insertion of the ligament; further, in the description of the hinge of *Unio Lottneri* (*Anthracosia acuta*) the following expression occurs:—"Das Schloss besteht aus einem dicken, vorspringenden, gekerbten Zahne hinter dem Wirbel [anterior], und einer langen, flachen Leiste vor demselben" [posterior].

I am inclined to think that what has been mistaken for the posterior lamellar lateral tooth is the upper edge of the flat hinge-plate, which is bounded above by the longitudinal groove for the insertion of the external ligament; this upper edge of the hinge-plate, being below the level of the superior border of the shell, therefore becomes apparently very prominent. On this point Ludwig states, "Das Ligament (Schlossband) lag ausserhalb längs der Leiste," which, I think, bears out my view. The hinges of Ludwig's *Unio batilliformis*, *U. crassidens*, and *U. lepidus* are pure artistic inventions, and are in the original specimens either very incomplete or partially covered up by the opposite valve. Yet these figures and the descriptions are quoted by Professor Amalizky as intermediate forms.

Considering the great variation of hinge-structure which obtains in a single

species of *Carbonicola* from the Coal-measures, I think it very unwise to rely on minute differences of this structure for the differentiation of genera; for, if this were to obtain, it would be necessary to divide one or two *species* into several *genera*. Whatever amount of differentiation may have become permanent in Permian times, and therefore of generic value, it is impossible to judge, on account of not having such fossils from British Permian beds, and non-access to specimens.

Professor Amalizky unfortunately only figures in his first great work two forms of the hinge of *Anthracosia*, one of which is a fac-simile of King's original figure of *Anthracosia Beaniana;* the other is the hinge of *Anthracosia Venjukowi*, which, from the drawing, appears to have no structural relation to the former. It is a type I have never met with in Great Britain. With regard to the hinge of *Carbonicola*, fac-similes of Ludwig's drawings are given in seven out of the ten figures; one of the remainder being the reproduction of an excellent figure of *Anthracosia securiformis* (*aquilina*) by Koenen,[1] in which the long lamellar lateral tooth posteriorly is conspicuously absent. The original of this, I think, I have seen at Berlin. Thus Prof. Amalizky depends on the accuracy of the figures of others for the facts on which he bases his division of the genus. Furthermore, he has adopted Sir J. W. Dawson's name "*Naiadites*," which, as originally described, contained shells of the three genera, the majority unfortunately not being related to the forms for which Professor Amalizky has borrowed the name, the typical forms belonging to *Anthracoptera* and *Anthracomya* (Salter), for the former of which the name *Naiadites* is to be retained.[2] In addition, the forms placed by Professor Amalizky under *Naiadites* are often found in young specimens of *Carbonicola*, and may in a few cases be permanent in the adult. In a subsequent paper[3] Prof. Amalizky figures a number of hinges of *Carbonicola* and *Anthracosia,* indicating as the posterior lateral teeth of the former certain small irregularities, which do not, however, appear to merit the description of "long lamellar teeth." Certain markings are seen, however, in Pl. V, fig. 38, and Pl. VI, fig. 2; and it is possible that they may be indications of, or primitive attempts at, the formation of the lateral tooth, which has become well developed in more recent members of the *Unionidæ*.

An important consideration, which must not be passed over, is the fact that, apart from the supposed differences in the hinge-plate, there are no other characters which can be relied upon to determine between specimens of Professor Amalizky's *Carbonicola* and *Anthracosia;* and here in England it is very seldom that interiors can be seen. A generic division by this character would serve no good purpose; and in the majority of cases it would be quite impossible, when the hinge is not visible, to say to which genus the shell belonged.

[1] 'Zeitschrift Deutsch. Geol. Gesellsch.,' vol. xxxiii, 1881, p. 86, pl. xxvi, figs. 6 and 7.

[2] 'Quart. Journ. Geol. Soc.,' vol. l, pp. 435—442, August, 1894.

[3] Read January, 1893, before the Geological Section of the St.-Petersburg Nat.-Hist. Society.

In 1881 Professor Koenen gave a good description of the hinge-plate of Ludwig's *Unio* (*Anthracosia*) *securiformis* in the 'Zeitschrift Deutsch. Geol. Ges.,' vol. xxxiii, p. 686, as follows: "Die rechte Schale von *Anthracosia* trägt unter resp. ein wenig hinter dem Wirbel einen dicken, stumpfen Cardinalzahn mit einer oder ein Paar Kanten und darunter eine ganz flache, mitunter gekerbte Einsenkung des Schlossrandes; die linke Schale eine breite, nur wenig gegen den hinteren Schalrand geneigte Einsenkung des hier stärker geschwungenen Schlossrandes, und darunter eine Anschwellung desselben, welche allenfalls als schwacher Zahn gedeutet werden könnte. Vorn scheint die rechte Schale über die linke überzugreifen. Hinten ist, als Seitenzahn deutbar, eine stumpfe Kante auf dem Schlossrande der linken Klappe, und in der rechten eine flache Furche vorhanden." There is doubtful mention made here of a posterior lateral tooth, which, however, I fail to see in either the figures or the specimen which I had the opportunity of examining at Berlin.

It is difficult to know what King meant by "umbonal ligamental fulcra." He and, later, Salter seem to have supposed that *Anthracosia* possessed an internal cartilage, which occupied a cavity in the hinge-plate; indeed, the latter states,[1] "It [*Anthracosia*] certainly had an internal ligament. This is shown in a fine specimen in the Geological Society's Museum." Amalizky combats this statement, thinking that the observation must be a mistake. I consider that the striated furrow below and posterior to the umbo is for the attachment of the anterior and thickened portion of the external ligament, the striæ in the hollow in well-preserved specimens being due to the continuation of the lines of growth over the upper edge of the shell; and this termination of the lines of growth in the groove for the ligament occurs all along the edge of the shell.

It would seem, from the transverse section of the shell shown on Pl. XI, fig. 2, that some cavity was at times left, in which an internal, or the anterior part of the external, ligament may have been lodged; and I have returned to this question at page 48.

Many attempts have been made to connect the *Carbonicolæ* with the *Cardiniæ*; but it is doubtful whether Agassiz, the author of the latter genus, ever intended to include in it the Coal-measure Unios. I have been unable to verify this point, as I have been unable to see the original memoirs on the subject. De Koninck and de Ryckholt referred the Coal-measure Unios to Agassiz's *Cardinia*, of which genus Woodward[2] considered them to be a sub-genus. Quite recently Polig[3] and Koenen[4] have sought to show a close relation between *Anthracosia* (*Carbonicola*) and *Cardinia*. The former, however, does not discuss the question of a fresh-water habitat,

[1] 'Geol. Survey Mem., Iron Ores of South Wales,' pt. 3, p. 227.

[2] 'Manual of the Mollusca,' edit. 1, p. 470, 1851–6.

[3] 'Palæontographica,' vol. xxvii, p. 121, 1880. [4] Op. supr. cit.

and writes of them as "maritime Unionidæ;" while the latter considers that the position of the accessory-muscle scar is diagnostic of *Cardinia*. But this is not so, for the position of this scar in *Carbonicola* is very different from that which obtains in *Cardinia*. In *Carbonicola* the scar is above that of the adductor, between it and the upper border of the shell; while in *Cardinia* the scar is internal to the adductor, and within the pallial area. Moreover the position of the anterior adductor is almost marginal in *Carbonicola*, and situated in the superior-anterior angle of the shell; while this is not the case in *Cardinia*. The hinge, too, in *Cardinia* is totally different from that of *Carbonicola*, and is described by Woodward[1] as "cardinal teeth, obscure, laterals 1—0, 0—1, remote, prominent." Zittel,[2] Steinmann, and Doderlein[3] still retain *Anthracosia* as a sub-genus of *Cardinia*. Salter[4] hazarded the view that *Anthracosia* (*Carbonicola*) might be allied to the *Myadæ*. He says, "*Anthracosia* was, I believe, a burrowing shell. Among beds, where these fossils were the only bivalves, I have seen bivalve burrows answering to them in size. It had certainly a thick and wrinkled epidermis, as the *Myadæ* have, and no eroded beaks as is common in *Unio;* but the pallial line was simple and the valves close."

I have never seen specimens of *Carbonicola*, except perhaps occasionally and accidentally so, in an erect or vertical condition in the shales; they all lie with their long axes parallel to the planes of the bed, and they are often covered with *Spirorbis;* both of which facts militate strongly against the view that they were burrowers. Indeed, I think that the characteristics of the *Carbonicolæ* show a close connection with lower forms, in the transverse articulating hinge-plate and the persistence of the striations formed by lines of growth both in the lunule and in the groove for the external ligament posterior to the umbo. The common occurrence of an oblique shallow constriction and sinuated lower border points to a byssiferous ancestor, and a probable line of descent from a Mytilus-like form.

With regard to the question of eroded umbones in *Carbonicola*, some authors have described such a condition. The first was Professor Prestwich, whose note on the point I have quoted before.[5] Goldfuss[6] stated that the umbones of his specimens were "abgeriebene," though this word does not usually carry the meaning of erosion, but rather that of polish by friction. Ludwig[7] also uses the term "mit abgeriebenem Wirbel," but I could not make out that his specimens had been eroded anterior to fossilisation. Still a large number of specimens from the roof of the Cockshead Seam of North Staffordshire exhibit unimpeachable

[1] Op. supr. cit.

[2] 'Handbuch der Palaeontologie,' vol. ii, p. 61, 1881.

[3] 'Elemente der Palaeontologie,' 1892, p. 265.

[4] 'Geol. Surv. Mem., Iron Ores of South Wales,' pt. 3, pp. 226, 234, 236, 1861.

[5] P. 5.

[6] 'Petrefact. Germ.,' p. 180.

[7] 'Palaeontograph.,' 1859, Band viii, p. 33.

erosions (see Pl. IV, figs. 8—12). It is curious, however, that I have been able to make out this peculiar feature in no other species of *Carbonicola*, but erosion is present in similar forms from other localities; and this eroded condition of the umbones is by no means universal, even in the bed mentioned. I conclude that erosion would not take place provided that the periostracum remained intact, and also that the presence of sufficient $CaCO_3$ to neutralise the free carbonic acid in the waters in which these shells lived would largely prevent erosion. It is still, however, a matter of great uncertainty as to what is the real cause of erosion in Unios; and, indeed, in some localities they are not thus affected.

The nearly universal occurrence of truncate and somewhat ventricose varieties of each species suggests the question as to the possibility of the diœcious character of these Coal-measure Lamellibranchs; this, of necessity, is a question which cannot be settled in the absence of all data, though Ludwig and Achepol have ventured so far as to describe certain tumidities in the upper and posterior part of specimens as due to the situation of the ovary—a somewhat unwarrantable assumption, judging from what is known of the sexual organs of the *Unionidæ*.[1]

It is interesting to note that similar variation of forms occurs in the species of *Anthracomya* and *Naiadites*

I have considered it unnecessary to raise *Anthracosia* to the dignity of a Family, as I think that of the *Unionidæ* to be sufficiently wide to embrace a genus which seems to present only one important difference from the other genera included in it, viz. the abnormal (*quâ Unio*) situation of the anterior-pedal muscle-scars.

1. Carbonicola robusta (*Sowerby*). Plate I, figs. 1—6; Plate II, figs. 1—6, 9—11.

Unio robustus, *Sow.* Trans. Geol. Soc., ser. 2, vol. v, pl. xxxix, fig. 14, 1840.
Cardinia robusta, *de Koninck.* Anim. Foss. Belg., 1842–4, p. 71, pl. ii, fig. 1.
Unio robustus, *Brown.* Foss. Conch., 1849, p. 181, pl. lxxxviii, fig. 16.
Carbonicola subconstricta, var. robusta, *M'Coy.* Brit. Palæozoic Foss., 1855, p. 515.
Non Anthracosia robusta, *Hull.* Coal-fields of Gt. Britain, 1861, pl. i, fig. 1.
— — *Salter.* Mem. Geol. Survey, Country round Wigan, Sheet 89, p. 37, fig. 2, 1862.
Non — — *Wardle.* Geol. of Leek, 1863, pl. iv, fig. 13.
Anthracosia crassa, *Achepol.* Niederrheinisch.-Westfälische Steinkohlen-Gebirge, Atlas, 1880—1883, Supp., pl. i, figs. 19, 20, 1880–83.
— caudata, *Achepol.* Ibid., Supp., pl. iii, fig. 49, 1880–83.
— robusta, *Ward.* Trans. North-Staffs. Inst. Min. Mech. Engineers, vol. x, p. 127, pl. i, fig. 1, 1890.

[1] Though generally said to have the sexes distinct, I have never by dissection been able to satisfy myself that such was the case in the Unionidæ.

Specific Characters.—Transversely triangular, tumid; anterior end rounded, excavated above by lunule; and its anterior-superior angle almost a right angle, and much below the level of the umbones. Posterior end is gradually compressed and bluntly pointed and narrowed from above downwards by a rapid descent of the superior border.

Umbones contiguous, situated at the junction of the anterior and middle thirds of the shell; swollen and prominent, forming the apex of the triangular shell. The posterior part of the hinge-line slopes rapidly from the umbones. External ligament is very prominent, and terminates abruptly; posterior to it is a V-shaped trench, becoming shallower and narrower posteriorly between the bevelled edges of the hinge-plates. Inferior border is bluntly rounded in front, straight or sinuate behind; in the latter case the posterior-inferior angle of the shell has a downward direction.

There is often a broad constriction posterior to the greatest tumidity of the shell, directed downwards and backwards.

Hinge-plate consists of three parts. Anteriorly there is an elongated triangular surface, bevelled slightly at the expense of its lower border, the upper border becoming slightly thickened into an elongated ridge, which forms the lower border of the lunule; this ridge terminates suddenly at a point just anterior to or beneath the umbo, and is excavated posteriorly by a broad concavity, deeper anteriorly, but becoming gradually shallower as it passes into the posterior part of the hinge-plate. This concavity extends from just beneath the point of the umbo to the inferior margin of the hinge-plate, which is lost in the depression. The concavity is transversely striate; the striæ appear to be continuous with those of the lunule, which dip down into it. Posterior to the concavity there is a broad plain vertical surface, elongated triangularly, bevelled at the expense of its upper border, which, narrowing as it passes backwards, becomes lost in the external surface of the shell at its superior posterior angle.

Interior normal. Anterior-adductor scar almost marginal, deep, and oval. Posterior-adductor scar shallow. Surface with fairly strong concentric lines of growth, which are contiguous anteriorly, becoming separated as they pass over the body of the shell, often with a slight sinuation posteriorly, when they become reflected at a rounded right angle, to be lost in the superior border along the groove of the external ligament. Shell thick.

	Pl. I, fig. 1.	Another specimen, Pl. II, fig. 1.
Length antero-posteriorly .	90 mm.	55 mm.
Dorso-ventrally . .	58 mm.	35 mm.
From side to side . .	42 mm.	20 mm.

Localities.—In the Upper Coal-measures of Scotland. Rankinstone Ironstone,

near Ayr, Dalmellington, Airdrie, Cummock and Shotts, and above the Drumgray Coal of Lanarkshire. England: Lower yard seam, Fulledge Colliery, Burnley. Above the Arley Mine, Lancashire. Middle Coal-measures, Pendleton, Lancashire. Lofthouse and Killingback-beds, near Leeds. Roof of Shale Coal, Wakefield. Brockwell Seam, Wylam, Northumberland. Above the Holly Lane and Bowling Alley, and 10-foot Seams. Shale above 4-foot Coal, Wetley Moor. Shale above Woodhead Coal, Froghall, all in the Lower Coal-measures of North Staffordshire. Coalbrookdale (Pennystone Beds). Alfreton, Tibshelf (small form), and Codnor Park, Derbyshire.

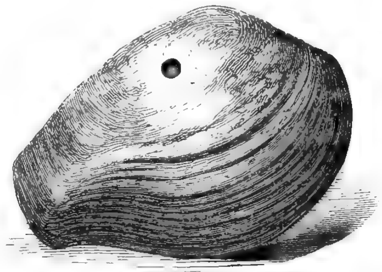
Observations.—Through the kindness of Prof. Prestwich I have been able to study and figure the original type-specimen, Pl. I, figs. 2, 2 *a*, which apparently differs widely from Salter's type; but it was pointed out to me by Mr. H. Bolton, of the Manchester Museum, Owens College, that Prof. Prestwich's shell was crushed and incomplete, as was, indeed, shown in the original drawing, the lines of growth terminating abruptly without becoming reflected upwards to the superior border. A smaller form, Pl. II, fig. 3, kindly lent me by Dr. John Young, of Glasgow, approaches somewhat to the original figure, its posterior end not being developed. This I believe to be a young state of the shell, from the fact that a series of intermediate specimens can be shown. Pl. I, fig. 6, from the Braidwood Collection of Dr. Hunter, and Pl. II, fig. 3, another of Dr. J. Young's specimens, are such forms.

De Koninck's figure of this shell ('Les Animaux Fossiles de la Belge,' pl. ii, fig. 1) is like Dr. John Young's small specimen; but this species seems to be rare in the coal-fields of the Continent, as no other author, except perhaps Achepol ('Niederrh.-Westf. Steinkohlen-Gebirge, Atlas,' Suppl. 1, figs. 19, 20, *A. crassa;* and Suppl. 3, *A. caudata*), records its presence; and, except at Brussels, I have seen none in any museum abroad. M'Coy ('British Palæozoic Fossils,' p. 515), judging from Sowerby's figures of *Unio subconstrictus* ('Min. Conch.,' Tab. xxxiii, figs. 1—3; and *U. robustus*, 'Trans. Geol. Soc.,' ser. 2, vol. v, pl. xxxix, fig. 14), considered that the latter was only an adult form of the former, the figure of *U. robustus* appearing shorter and deeper than natural from the oblique fracture of the posterior end.

I have not seen very many hinge-plates of *C. robusta;* but, judging from those I have seen, this species seems to have possessed a more constant form than others. Mr. Salter figures a hinge-plate in the Appendix to the 'Geological Survey Memoir, the Country round Wigan,' which agrees very closely with Pl. II, fig. 9. In young forms the anterior part of the hinge-plate does not seem to be developed into a cardinal tooth to the extent which obtains in older specimens. In Salter's figure there is a little irregularity shown in the hinge-plate towards the posterior end: I have seen a similar condition in some of the interiors of other species of *Carbonicola*, and consider it to be the position of the

attachment of the posterior end of the external ligament, as is the case in the recent *Anodonta*.

The umbones of this species are seldom eroded. The only specimens in which I have seen this feature are from Codnor Park. One specimen from the Collection of Mr. Neilson, of Glasgow (see woodcut), appears to have been bored with a circular hole; and a similar hole is shown in one of Mr. Salter's figures (*op. supra cit.*). To what these holes are due it is impossible to guess, for Gasteropoda have never been found in the beds with *Carbonicola* (see also p. 74).



The pit for the reception of the cardinal tooth of the opposite valve is very large in the specimen figured, Pl. II, fig. 1 *a*, much larger than is necessary. The same feature may be observed in many of the valves on Pls. V and VI, and more particularly in the transverse section on Pl. XI, fig. 2. This raises a question as to the possibility of there having been present an internal ligament or cartilage lodged in this hollow, and the fact that striæ can be made out would also point to this conclusion; but this cartilage could not have been always present, as there is no room for it in many of the hinges figured on Pls. V and VI differing from that which I have considered to be the normal type. It is possible that this hollow lodged a process of the external ligament, which had here its anterior and strongest attachment. Whilst, however, on the one hand there are forms showing a slighter degree of development in the posterior end, there are others (Pl. II, figs. 1, 2), from Limerigg, Slamanuan, in the collection of Mr. Smith, of Kilwinning, which show a more elongated shape, with much smaller comparative dorso-ventral diameter; but these have the characteristic constriction at the junction of the middle and posterior thirds of the valves, and the beaked posterior end.

This species is the largest form of *Carbonicola*, and is very much larger than other members of the genus. In England the large form has a very limited distribution, both horizontally and locally. It is much more common in Scotland; though, there, it appears to keep to one horizon. In the North Midlands of England there is a dwarf form, but generally obtained crushed.

The shape is very characteristic; the comparatively great dorso-ventral depth and the tumidity in the anterior half of the shell are of diagnostic importance. Salter considered the form to be identical with *Unio rugosus* (*Pachyodon*, Brown).

2. CARBONICOLA RUGOSA (*Brown*). Plate II, figs. 7, 8, 8 *a*.

PACHYODON RUGOSUS, *Brown*. Ann. Mag. Nat. Hist., vol. xii, p. 391, 1843.
UNIO RUGOSUS, *Brown*. Foss. Conch., pl. xv, figs. 6, 7; pl. lxxiii, figs. 14, 15, 1849.

Specific Characters.—Subtriangular, ventricose. Umbones massive, subcentral, obtuse, tumid, incurved, and contiguous. Anterior end swollen; anterior border rounded, meeting the superior border at an angle rather greater than that of a right angle. Posterior end swollen; the superior border slopes rapidly downwards, forming a bluntly-curved posterior border. Inferior border uniformly convex.

Lunule broad, deep, and well marked. Ligament large, erect, extending from between the umbones half the length of the posterior hinge-line.

Valves uniformly convex, covered with fine striæ and rugæ of growth. Interior unknown.

Dimensions:	Antero-posteriorly.	Dorso-ventrally.	Laterally.
Mr. Wild's specimen	. 62 mm.	48 mm.	42 mm.
Specimen in Geol. Survey Mus. (incomplete)		48 mm.	41 mm.

Localities.—Ironstone, Hebden Bridge, Cant-Clough, Burnley,—horizon doubtful.

Observations.—This form appears to be allied to *C. robusta*, to which Mr. Salter ('Geol. Surv. Mem., Wigan,' p. 37, 1862) was inclined to refer it. But there are certain characteristics, as the more central position and the shape of the umbones, the deep elongated lunule, and the comparatively greater tumidity of the shell, which, taken in connection with the different horizon at which the shell occurs, have induced me, for the present, to retain Captain Brown's name. His original specimen is said to have come from the Hebden Bridge Ironstone, and the figure given is that of a perfect specimen; but I have been unable to trace it.

I only know of two specimens, both from the neighbourhood of Burnley, and these have been kindly lent me to figure by the Director-General of the Geological Survey and Mr. George Wild, but unfortunately both of these specimens are imperfect posteriorly.

The exact horizon of these specimens is doubtful, but it is certainly low down, possibly Yoredale. Mr. Wild writes me that he has no notes of the bed from which he obtained his specimen. That belonging to the Geological Survey Collection is labelled "Coal-measures."

3. CARBONICOLA ACUTA (*Sowerby*). Plate III, figs. 1—12; Plate IV, figs. 8—17; Plate V, figs. 1, 3—37, 39; Plate VI, figs. 1—43.

UNIO ACUTUS, *Sow.* Min. Conch., vol. i, p. 84, pl. xxxiii, figs. 5, 7, 1829.
— — *Defrance.* Dict. Sci. Nat., vol. xxxiii, p. 294.
— — *Hoeninghaus.* Verzeichniss Petrefact. Sammlung, 1829, p. 17.
— — — Neues Jahrbuch, 1830, p. 240.
Non — — *Dumont.* Géol. Liége, 1832, p. 356.
Non — — *Davreux.* Essai sur la constit. géolog. Liége, 1833, p. 101, pl. v, figs. 4, 8.
— — *Murchison.* Sil. Syst., 1839, p. 105, fig. c.
— TELLINARIUS, *Goldfuss.* Petrefacta Germaniæ, 1834–40, vol. ii, p. 180, pl. cxxxi, fig. 17, 1840.
CARDINIA ACUTA, *de Koninck.* Carb. Foss. Belg., 1842, p. 75, pl. I, fig. 8.
— — *Agassiz.* Translation Sow. Min. Conch., 1842.
— TELLINARIA, *de Koninck.* Carb. Foss. Belge, 1842, p. 77, pl. I, fig. 14; pl. H, fig. 5.
PACHYODON EXOLETUS, *Brown.* Ann. Mag. Nat. Hist., vol. xii, 1843, p. 392, pl. xvi, fig. 4.
— ANTIQUUS, *Brown.* Ibid., p. 394, pl. xvi*, fig. 4.
— TRANSVERSUS, *Brown.* Ibid., p. 395, pl. xvi*, fig. 5.
— LEVIDENSIS, *Brown.* Ibid., p. 395, pl. xvi*, fig. 8.
— AGRESTIS, *Brown.* Ibid., p. 393, pl. xvi, fig. 11.
UNIO TELLINARIUS, *Garner.* Nat. Hist. Staffordshire, 1844, p. 452, pl. E, fig. 23 (no name nor description).
— SENEX, *Brown.* Foss. Conch., 1849, p. 178, pl. lxxiii, fig. 31.
— AGRESTIS, *Brown.* Ibid., pl. lxxiii, fig. 20.
— TRANSVERSUS, *Brown.* Ibid., pl. lxxiii, fig. 21.
— LEVIDENSIS, *Brown.* Ibid., pl. lxxiii, fig. 30.
— EXOLETUS, *Brown.* Ibid., pl. lxxiii, fig. 25.
CARBONICOLA ACUTA, *M'Coy.* Palæozoic Fossils, 1854, p. 514 (description only).
ANTHRACOSIA ACUTA, *King.* Ann. Mag. Nat. Hist., 1856, ser. 2, vol. xviii, pl. iv, fig 5, p. 57.
UNIO LOTTNERI, *Ludwig.* Palæontographica, vol. viii, 1860, p. 183, pl. lxxii, figs. 1, 1 *a*, 2.
— TELLINARIUS, *Ludwig.* Ibid., vol. x, 1861, pl. iii, figs. 4 *a*—*d*.
ANTHRACOSIA ACUTA, *Salter.* Geol. Surv. Mem., Iron Ores of South Wales, 1861, pt. 3, pp. 226 and 228, pl. ii, figs. 20, 21.
Non — — *Rœmer.* Lethæa Geognostica, 1876, pl. xliv, fig. 9.
— SECURIFORMIS, *Achepol.* Niederrheinisch.-Westfälisch. Steinhohlengebirge, Atlas, 1880–83, p. 47, pl. xiii, figs. 3—6.
— — — Ibid., p. 59, pl. xvii, fig. 3.
— — — Ibid., Suppl., pl. iii, fig. 1.
CARDINIA TELLINARIA, *Achepol.* Ibid., pp. 40, 41, pl. xi, figs. 4, 9.
ANTHRACOSIA GRACILIS, *Achepol.* Ibid., Suppl., pl. iii, figs. 38, 39.
— RECTANGULARIS, *Achepol.* Ibid., p. 86, pl. xxvii, figs. 1, 2.
— — — Ibid., Suppl., pl. iv, fig. 12.
— FABRICII, *Achepol.* Ibid., pp. 119, 120, pl. xxxvi, figs. 5, 11.

ANTHRACOSIA FABRICII, *Achepol.* Niederrheinisch.-Westfälisch. Steinhohlengebirge, Atlas, 1880–83, Suppl., pl. iv, figs. 61, 62.
— RÖMERI, *Achepol.* Ibid., p. 136, pl. xli, figs. 1—20.
— ACUTA, *Ward.* Trans. N.-Stafford. Inst. Min. and Mech. Engineers, vol. x, p. 128, pl. i, fig. 8, 1890.

Specific Characters.—Shell elongate, transversely ovate, tumid; anterior end short, bluntly rounded, swollen. Posterior end produced, gradually compressed and narrowed by the approximation of the superior and inferior borders, with a more or less acutely pointed posterior-inferior angle, above which the border is obliquely truncate. Hinge-line straight, about two-thirds the length of the shell. Umbones gibbous, broad, fairly prominent, not contiguous; beaks deflected very slightly forwards, situated at the junction of the anterior and middle thirds of the shell. Lunule elongated, and, when both valves are together, ovate; striated above by the lines of growth curving round and becoming reflected into the inner face of the umbo; smooth and plain for a narrow space along the edge of the hinge. Neutral margin bluntly rounded anteriorly, the curve being continuous with the anterior border; at about the centre of shell it becomes straight, very slightly sinuous, and directed upwards. On each side of the posterior part of the upper border, which is somewhat erect, the shell becomes slightly constricted longitudinally. Cartilage external, extending about half the length of the hinge-line.

Shell thick, almost massive at umbones. Surface with coarse irregular concentric lines of growth.

Anterior- and posterior-adductor scars deep; the former almost marginal, containing at times pearl-like growths.

The hinge apparatus is very variable; but three distinct types may be recognised, which I purpose describing as α, β, and γ. These different forms occur in the same bed, and are connected by transitional forms.

Form α (Pl. V, figs. 1 and 3—16).—The hinge-plate may be divided into three portions. In the right valve anteriorly there is an elongated triangular surface, which may or may not be bevelled and facetted at the expense of the lower border. The superior border is slightly thickened or ridged to form the cardinal tooth, behind which is a broad concavity, becoming shallow posteriorly, when it passes into a broad vertical smooth plate, which rapidly narrows, to be lost on the inner surface of the shell near the posterior end. In the left valve anteriorly the lunule passes into an elongate concavity, while there is a more or less marked lip below the lunule and anterior part of the depression, smooth or facetted, and at times bevelled at expense of upper border. Posterior to this concavity, which terminates abruptly, is a thickened boss, the cardinal tooth, which may or may not be separated from the posterior part of the hinge-plate by a depression, which receives an accessory tooth, if one be present in the right valve. The posterior

part of the hinge-plate is smooth and vertical as in the right valve, and slightly bevelled from below upwards.

The form β, Pl. V, figs. 17—34, has lost the simple character of right-valve tooth anterior, socket posterior, and left-valve socket anterior, tooth posterior, and has in the right valve its anterior portion much bevelled at the expense of its lower border; while the upper border of the hinge-plate is raised into a long irregular tooth, which extends considerably behind the umbo, and has, posterior to it, a narrow wedge-shaped depression, with apex upwards, to receive the tooth of the opposite valve.

The posterior part of the hinge-plate is as in the form described above. The great feature here is the absence of the broad depression in the right valve below the umbo, and in the left valve anterior to it.

In the left valve, anteriorly, the lower part of the hinge-plate is produced, while its upper border is reduced, and becomes hollowed longitudinally to receive the elongated tooth of the right valve, behind which is an elevated collar sloping backwards, against which the tooth in the right valve rests.

The posterior part of the hinge-plate is rarely a plain surface; at times it is twisted on itself, and may be excavated in places, as in recent Unios, for the attachment of the posterior extremity of the ligament. The form of lock is vertical, the tooth of right valve being superior to that of the left.

It has, I think, from the observation of transitional forms, been evolved by the elongation backwards of the tooth of the right valve, encroaching on the concavity for that tooth in the left, causing a corresponding atrophy of that tooth; at the same time, a bevelling of the lower part of the anterior portion of the hinge-plate of the right valve, and a corresponding increase in the lower part of the anterior portion of the left, took place.

The third form, γ, Pl. V, fig. 37, differs from the type β in having in the right valve the one long cardinal tooth bifid, with a triangular pit between the two portions. The left one has a single median cardinal tooth, with a concavity in front and behind it. The vertical locking arrangement, by bevelling the edges of the hinge-plates of the respective valves, is as in form β, so that in form γ a much stronger lock is obtained, having both a vertical and horizontal articulation. Occasionally I have met with a transposition of the hinge arrangement, the cardinal tooth then being anterior, and overlapping that of the right (Pl. V, fig. 7).

Dimensions:

Antero-posteriorly . . .	54 mm.
Dorso-ventrally . . .	28 mm.
Laterally	20 mm.

Localities.—England: Yard-coal, Chesterton; Cockshead Coal-roof, Adderley Green; Ten-foot Coal, Bucknall; Banbury Seam, Bucknall; Knowles Bass, Longton;

Bowling Alley, over Four-foot Coal, Wetley Moor; N. Staffs Coal-field; above the Broach Coal, Dudley; Middle Coal-measures of Bolton, Bury, and Oldham; Coal-measures, Nottingham; Unston, Derbyshire. South Wales: Rosser Vein, Cwm Bryn ddu, Jack mine, Cwm Aman. Blue Vein, Gantre; Bottom Vein, Sirhony. Stanley Main; Wakefield; Sheden; Lowmoor, Middleton; Band, near Townelly Seam, West Wylam. Eltingham Colliery, Prudloe; Northumberland and Durham Coal-field. Scotland: Kilmarnock; Shotts; Airdrie, Shettleston, U. C.-m.; Eight-foot Coal, Scoonie; roof of Eight-foot Seam, Durie Colliery; Fifeshire Coal-field.

Observations.—This species has a wide distribution, both horizontally and vertically. Its form, however, as might have been expected, varies considerably. The type form (Sow.), Pl. III, fig. 1, is perhaps the most common, but the varieties do not seem to be due to local or horizontal environment. I find them all occurring in numbers in the roof of the Cockshead Seam of the North-Staffordshire Coal-field, with members of an intermediate form, indicating the lines of variation. In many specimens there exists a feature denied to this species by M'Coy, namely, a subconstriction or oblique sulcus, widening as it approaches the ventral border, and showing a close relationship to similar forms of *C. robusta*, with the smaller elongated form of which shell, indeed, *C. acuta* is closely allied, differing chiefly in the relatively smaller dorso-ventral and lateral measurements.

M'Coy relied on "the lengthened form, straight insinuate ventral margin, the side without any oblique concavity, ... as well as the greatest width [dorso-ventral] being a little behind the beak, instead of from the apices," as characteristics of this species; yet, while many shells agree with this description, one or other of these characters often varies.

I think, with M'Coy, that the forms described and figured by Brown (*op. cit. supra*) as *Pachyodon*, and *Unio exoletus*, *antiquus*, *transversus*, and *Levidensis*, are forms of this species; and to these I would add the forms *Pachyodon* and *Unio agrestis;* but it is impossible to judge accurately from drawings only, and the original specimens have entirely disappeared. Yet, from other localities, I know examples of these forms which I consider to belong to this species.

I am disposed to regard, from inspection of the figures and Goldfuss's description, *Unio tellinarius* as an example of this species. De Koninck appears to have copied Goldfuss's figure, but it is difficult to be certain as to identification, as the original specimens have disappeared.

M'Coy thought that his *Carbonicola subconstricta* was synonymous with the *Unio* and *Pachyodon tellinarius* of the above authors.

Fleming has curiously enough ('History of British Animals,' p. 417, 1828) referred *Unio acutus*, Sowerby, to the Middle Oolite; but this must be an error, for Sowerby gives "Bradford," Yorkshire, as the locality of this shell.

I have been permitted by the kindness of Dr. H. Woodward to figure the

originals of Sowerby's types, which are in the "Sowerby Collection" in the British Museum (Nat. Hist. branch). Fig. 1, Pl. III, is to be regarded as the most typical; but I question whether figs. 2 and 3, Pl. III, do not really belong to *C. subconstricta*, being rather elongated forms of that species; because the umbones in these two specimens do not rise gradually from the shell, as in Pl. III, fig. 1 (and this I have regarded as one of the specific features in *C. acuta*), but are sharply marked off from the surface, as in the specimen of *C. subconstricta*, Pl. VII, figs. 5—15. Indeed, on comparing Sowerby's second specimen of his *Unio acutus* (Pl. III, fig. 2) with his specimens of *U. subconstrictus* (Pl. VII, figs. 5 and 6), little if any distinction can be made between them. M'Coy ('British Palæoz. Fossils,' p. 515) considered that the *Unio aquilinus* of Sowerby ('Geol. Coalbrookdale,' pl. xxxix, fig. 12) was identical with *C. acuta;* but he was in error in this idea, not recognising the characteristically different shape and proportions of the anterior end and the general obliquity of the shell of *C. aquilina;* indeed, there should be no difficulty at all in distinguishing between these two forms.

Few workers in this field have considered it possible that young and immature forms might be met with, and been able to resist the temptation of inventing fresh specific names for such; and amongst these, Brown, Ludwig, and Achepol are conspicuously to the front. I think, from a personal observation of the original specimens, there can be no doubt that Ludwig's *Unio Lottneri* is an elongate variety of the species under description.

Salter's figures in his 'Iron Ores, South Wales, &c.,' pt. 3, pl. ii, figs. 20, 21, do not possess the straight margin of the posterior part of the ventral border. In these two figures the anterior and posterior ends approached more closely to Martin's *Mya ovalis* and Sowerby's *Unio centralis;* but the shells are much elongated transversely. *Unio Lottneri,* Ludwig, is probably identical with Salter's figures.

The great variation in the form of the hinge is very difficult to understand. The hinge-plates figured on Pls. V and VI, with the exception of Pl. V, figs. 1, 2, 32, and Pl. VI, figs. 43 and 44, are all from the same bed—a band of ironstone above the Cockshead Coal, and were obtained by myself from an old pit-mound at the Hulme Colliery, where they had weathered out of the matrix in a fragmentary condition; the hinge itself, owing to its thickness, generally being preserved. I have been able to obtain a very large number of examples, very few of which are exactly alike. Besides the three forms I have ventured to describe, and those showing intermediate features, there are others, of which figs. 4, 5, 6, 12, and 13, Pl. VI, may be taken as examples, showing a total departure from the other forms, and the absence of anything like a cardinal tooth. Pl. VI, fig. 6, shows the anterior two-thirds of the hinge of the right valve; and all the articulating arrangement present is a bevelling of the lower edge of the hinge-plate. In other cases the hinge-plate has been much hollowed out, Pl. VI, figs. 13—16.

A large number of genera might have been founded on the hinge-plates figured, had the specimens been found in different beds; and thus it becomes very apparent that a classification of the *Unio*-like forms of the Coal-measures, founded on slight differences in the hinge, is not justifiable.

Indeed, we find in this one species the edentulous forms which Prof. Amalizky would designate as *Naiadites*, and those with cardinal teeth only, which he would call *Anthracosia;* and a couple of rare forms (Pl. V, fig. 38, and Pl. VI, fig. 2) which have a trace of a posterior lateral tooth—the only specimens indicating such a condition which I have seen, and which would be referred by him to *Carbonicola.*

I believe that no other genus of shells, fossil or recent, exhibits such a curious inconstancy in a character which is generally so regular as to be used as a mark of generic import, and it is difficult to see what conditions could have induced this variation. Living gregariously, with precisely the same environment, and probably interbreeding very closely, it might be natural to suppose that a constant type would have resulted, rather than the amount of variation which really obtains. I cannot make out that any one form of hinge is peculiar to any particular form of *Carbonicola acuta;* nor is there much evidence to show that an equal amount of variation is to be found in other districts, except that Mr. John Ward, F.G.S., has a fine series of interiors of *C. acuta* from the ten-foot seam of North Staffordshire, in which a similar amount of variation is to be seen.

3*. Carbonicola acuta, var. rhomboidalis, nov. Plate III, figs. 13—21; Plate IV, figs. 1—7.

General Characters.—As in *C. acuta*, but the shape is more quadrilateral and less produced transversely. The dorso-ventral measurements are comparatively greater, and the umbones more anterior; while the posterior end, instead of becoming compressed and narrowed, retains its tumidity till close to the posterior border. The posterior slope is slight and inflated; the posterior end very bluntly truncate. The lines of growth posteriorly become bent upwards at a right angle, and are crowded together.

There is often a marked constriction of the surface of the valve, becoming very wide at the inferior border; and this may give rise to the appearance of an obsolete blunted ridge posterior to it, and to the production of the posterior inferior angle of the shell downwards, so that it becomes beaked. In some specimens the lines of growth become oblique to the long axis of the shell (Pl. III, figs. 13, 19).

Dimensions:

Dorso-ventrally	26 mm.
Antero-posteriorly	41 mm.
Laterally	18 mm.

Localities.—Cockshead Coal-roof, Adderley Green.

Observations.—Although this form is very distinct from the types of *C. acuta*, it is nevertheless connected with it by a well-marked series of intermediate forms, and it is impossible to divide them into distinct species. I have therefore considered the extreme form as a variety of *C. acuta*, and have figured a series showing the passage of one into the other. All the specimens came from the roof of the Cockshead Coal of Adderley Green. I have chosen a series of adult specimens of about the same stage of growth in order to make it more easy to follow the transition of shape.

The feature on which Sowerby and M'Coy relied so much for the diagnosis of *C. subconstricta* is well marked in this variety,—more so, indeed, than in the specific type itself. It is probable that the variability in shape has some connection with the variableness of the hinge-character in *C. acuta;* and it will be noted, too, from the figures, that the variety as well as the type-species was subject to erosion of the umbones. A similar variation between an acute and a more quadrate form obtains in *C. aquilina.*

4. Carbonicola ovalis (*Martin*). Plate IV, figs. 18—22; Plate V, fig. 38.

Mya ovalis, *Martin*. Petrefact. Derb., 1809, pl. xxvii, figs. 1, 2; pl. xxviii, fig. 5.
Non Unio uniformis, *Sow.* Min. Conch., 1812, p. 84, pl. xxxiii, fig. 4.
Syn. — acutus, *Dumont.* Geol. of Liége, 1832, p. 356.
— — *Davreux.* Essai sur la constitution géognostique de Liége, 1833, pl. v, figs. 4, 8.
— carbonarius, *Goldfuss.* Petrefact. Germ., 1834-40, p. 181, pl. cxxxi, fig. 19.
— tellinarius, *Goldfuss.* Ibid., p. 180, pl. cxxxi, fig. 16.
— centralis, *Sow.* Trans. Geol. Soc., 1840, ser. 2, vol. v, p. 491, pl. xxxix, fig. 13.
— (no specific name), *Rhind.* Age of the Earth, 1838, pl. ii, fig. F.
Cardinia ovalis, *de Koninck.* Carb. Foss. Belg., 1842-4, p. 74, pl. H, fig. 2.
— atrata, *de Koninck.* Ibid., p. 75, pl. H, fig. 3.
Pachyodon Rhindii, *Brown.* Ann. Mag. Nat. Hist., vol. xii, 1843, pl. xvi, fig. 2.
Unio Rhindii, *Brown.* Foss. Conch., 1849, p. 187, pl. lxxiii, fig. 5.
Non Anthracosia ovalis, *Salter.* Geol. Surv. Mem., Iron Ores S. Wales, pt. 3, 1861, p. 228, pl. ii, fig. 22.
— centralis, *Hull.* Coal-fields Gt. Britain, 1881, p. 38, pl. ii, fig. 4.
Non — — *Ward.* Trans. North-Staff. Inst. Min. and Mech. Engineers, vol. x, 1890, pl. i, fig. 16.
Non — subnucleus, *Amalizky.* Palæontographica, vol. xxxix, 1892, p. 156, pl. xx, figs. 19, 20 (said to resemble *Anthracosia ovalis, centralis,* and *uniformis*).

Specific Characters.—Transversely oval with rounded ends; the umbones are more central than in *C. acuta*, and the inferior border is regularly curved, having a convex outline. This curve passes gradually into the anterior and posterior borders, so that the anterior and posterior ends are both regularly rounded. Interior—as in *Carbonicola acuta.* Exterior—striæ and lines of growth concentric.

Dimensions, Sowerby's type of *Unio centralis:*

Antero-posteriorly	35·5 mm.
Dorso-ventrally	23·5 mm.
Laterally	15 mm.

Observations.—This somewhat infrequent form I regard as closely allied to *C. acuta.* Indeed, had it not been for the fact that Martin figured and described the shell, I should probably have considered the form as *C. acuta.* It occurs occasionally in the *C.-acuta*-bed of North Staffordshire (Cockshead roof).

Sowerby, in his 'Mineral Conchology,' substituted the name *Unio uniformis* for Martin's *A. ovalis*, for reasons of nomenclature; but the shell which he described is said to have come from Felmersham, in Bedfordshire, and is therefore an Oolitic species, and not in any way related to Martin's form, which was from the ironstone of Tupton Moor and Staveley. Martin's original specimen has disappeared, but it had the characteristically curved lower border rounded off anteriorly and posteriorly. Martin describes "one end pointed," but the figure shows for the posterior end a different shape from the ordinary form of *C. acuta.*

I regard Sowerby's form of *Unio centralis*, from Coalbrookdale, pl. xxxix, fig. 13, in Prof. Prestwich's memoir, as identical with Martin's species, and I have been permitted, by the kindness of Prof. Prestwich, to re-figure the original specimen, Pl. IV, fig. 18. This specimen shows umbones more central than usual, but this is due to some imperfection of the posterior end. Pl. IV, fig. 19, is a cast of another specimen from the same locality, and is in the Nottingham Museum. One other specimen from the same collection is in Pl. IV, fig. 22, from Butterley, Leicestershire. Pl. IV, figs. 20 and 21, are forms lent me by Mr. J. Neilson from the Kenmuir and Clydesdale pits near Glasgow, the latter of which shows a form intermediate between *C. acuta* and *C. ovalis.*

Salter's figure of *Anthracosia ovalis* in the 'Geological Survey Memoir on the Iron Ores of Great Britain,' part 3, pl. ii, fig. 22, is, I think, that of a totally different shell, viz. *Carbonicola turgida.* The hinge-characters are shown on Pl. V, fig. 38, in a specimen which I obtained from the Cockshead rock, which lies some little way above the Cockshead Bass (the *C.-acuta*-bed).

It has the form γ, which I have described above under *C. acuta:* thus in the right valve a central subumbonal tooth, with concavity anterior and posterior to

it; in the left valve a split cardinal tooth, which receives between its two halves the tooth of the opposite valve; anterior and posterior laterals are absent. In the figure will be noticed a faint oblique line on the posterior part of the hinge-plate, which, with a similar occurrence in Pl. VI, fig. 2, are the only indications of horizontal lateral teeth that I have met with. Pl. V, fig. 38, contains a small pearly nodule, well shown at "a" in the drawing.

That this form of hinge-plate (γ) is not confined to *C. ovalis* is certain, I think, from the occurrence of a similar form in specimens having the typical shape of *C. acuta*.

Prof. Amalizky[1] has referred a new species of his, named *Anthracosia subnucleus*, from the Permian formation of the Oka Volga Basin, as allied to the forms—*U. ovalis*, Martin; *U. centralis*, Sow.; *U. uniformis*, Sow.; *U. nucleus*, Brown; and *U. ovalis*, Salter. Judging, however, from the figures, dimensions, and description, his shell is totally different from the form under discussion, and I have shown above that the forms referred to are themselves very different, one of them being from the Oolite.

Localities.—England: Tupton Moor and Staveley. Roof of the Cockshead Seam and the Cockshead Rock, Lower Coal-measures of North Staffordshire. Pennystone Beds, White Flats, Blue Flats—Coalbrookdale. Butterley, Leicestershire. Old Coal, South Wales. Scotland: Kenmuir and Clyde Pits, Lanarkshire Coal-field.

5. Carbonicola Polmontensis (*Brown*). Pl. VII, figs. 1—4.

Unio (from Coal-shale), *Rhind.* Age of the Earth, pl. ii, figs. c, d.
— Polmontensis, *Brown.* Foss. Conch., pl. lxxiii, figs. 32, 33.

Specific Characters.—Transversely elongate-oval; sides flatly convex. Umbones are much elongated transversely, narrowed, apart, and everted anteriorly, situated at two-fifths of the length of the shell from the anterior end, which is rounded. The posterior end is compressed and bluntly pointed. The hinge-line is straight, and in casts median. The interior of the shell shows fine striæ radiating from the umbones to the surface. Posterior slope obtusely rounded; upper surface expanded. There is an oblique, shallow, broad depression on the sides of the shell, most marked towards the posterior part of the inferior border. External characters unknown. Muscular scars normal. Pallial line not very far from the margin of the shell.

[1] 'Palæontographica,' vol. xxxix, 1892; 'Ueber der Anthracosien die Perm-formation Russlands,' 156, pl. xx, figs. 19, 20.

Dimensions:

Antero-posteriorly	48 mm.
Dorso-ventrally	27 mm.
Laterally	15 mm.

Locality.—Coal-shale, Polmont, near Falkirk. Springhill Colliery, near Kilmarnock. Kirkwood Upper Coal-measures, Ell-coal, Kilwinning, Ayrshire.

Observations.—I have met with this form only in Scotch localities. Unfortunately I have not seen any testiferous examples, and am quite unable to state anything as to the external characters of the shell. The form was originally figured by Dr. Rhind in his little work 'The Age of the Earth,' and was named *Polmontensis* by Captain Brown from the locality whence it was first obtained, and he refigured the shell, giving a typical figure of the umbones and upper surface of the shell as shown in a cast. In casts the peculiar long, narrow, widely-separated umbones are quite characteristic.

I figure specimens from the several Scotch localities, which are all in the Upper Coal-measures. The figures show a slight variation in shape.

The shell appears to have some resemblance to *C. acuta*, but it is flatter, and differs from that species in the peculiarity of the umbones.

6. Carbonicola subconstricta (*Sowerby*). Plate VI, fig. 44; Plate VII, figs. 5—15.

Unio subconstrictus, *Sow.* Min. Conch., vol. i, 1812, p. 83, pl. xxxiii, figs. 1—3.
— — *Defrance.* Dict. Sci. Nat., 1824, vol. xxxiii, p. 294.
— — *Dumont.* Constitution géologique Liége, 1832, p. 356.
— — *Goldfuss.* Petrefact. Germaniæ, 1834–40, pl. cxxxi, fig. 18.
Cardinia subconstricta, *Agassiz.* Trad. de Sowerby's Min. Conch. (1842), p. 58, pl. xxiii, figs. 1—3.
— — *de Koninck.* Carb. Foss. de Belgique, 1842–4, p. 73, pl. I, fig. 9.
Pachyodon subtriangularis, *Brown.* Ann. and Mag. Nat. Hist., 1843, vol. xii, p. 393, pl. xvi, fig. 6.
— Smithii, *Brown.* Ibid., p. 393, pl. xvi, figs. 7, 8.
— Embletoni, *Brown.* Ibid., p. 393, pl. xvi, fig. 9.
— Heyii, *Brown.* Ibid., p. 393, pl. xvi, fig. 10.
Unio subtriangularis, *Brown.* Fossil Conch., 1849, p. 178, pl. lxxiii, fig. 12.
— Smithii, *Brown.* Ibid., p. 178, pl. lxxiii, figs. 10, 11.
— Embletoni, *Brown.* Ibid., p. 178, pl. lxxiii, fig. 6.
— Heyii, *Brown.* Ibid., p. 178, pl. lxxiii, fig. 1.
Carbonicola subconstricta, *M'Coy.* Brit. Palæozoic Foss., 1855, p. 515.
Anthracosia Smithii, *King.* Ann. Mag. Nat. Hist., ser. 2, vol. xvii, 1856, pl. iv, fig. 6.

Specific Description.—Shell ovate; anterior end rounded and short. Posterior end obliquely truncate from above downwards and bluntly rounded. Somewhat

narrowed by a convergence of the dorsal and ventral margins. Inferior border uniformly and convexly curved, or there may be a concave sinuation in it posteriorly.

Umbones situated in the anterior one-third of the shell raised above the rest of the shell, tumid and very blunt, widely separated in casts and excavated internally in front, so that they appear to have an oblique direction forwards and outwards. Lunule wide, rapidly widening anteriorly, marked by longitudinal striæ, which are continuous with lines of growth of the shell. In those specimens which have a sinuated ventral margin an almost obsolete, shallow, broad, oblique constriction is seen on the side of the shell, commencing near the umbones, it passes downwards and backwards, gradually widening until it terminates in the sinuated portion of the inferior border.

Valves somewhat convexly flattened; greatest convexity is situated immediately below the umbones. Posterior slope bluntly rounded or angulated. Hinge-line straight in casts, and there is no indication of any anterior or lateral cardinal teeth. In right valve there is a single obliquely diverging tooth, with a pit posterior to it to receive the corresponding tooth of left valve.

Shell moderately thick, marked with concentric striæ and very fine lines of growth.

Plate VII, fig. 8, measures—

Antero-posteriorly	38 mm.
Dorso-ventrally	22 mm.
Laterally	15 mm.

Localities.—Low Moor, Bradford; Thin bed, Burnley.

Observations.—I have been permitted to refigure the original shells of Sowerby's figures of *Unio subconstricta* (Pl. VII, figs. 5—7) by the kindness of Dr. H. Woodward. The feature of the shallow oblique sinus is not at all uncommon in many other species of *Carbonicola*, and can no longer be regarded as a specific character. As a matter of fact, it is much shallower in the form under description than obtains in many specimens of *C. acuta* and *C. robusta;* indeed, M'Coy (*op. cit.*, p. 515) thought that *C. robusta* was only an adult form of *C. subconstricta*.

I know of only two specimens which retain the shell, and these are in the "Sowerby Collection" (British Museum). There is also a fine series of casts in the Woodwardian Museum at Cambridge, which nevertheless show very faint striæ over the lower part of the shell (figs. 8—10, Pl. VII).

The form of *C. subconstricta* appears to me to connect *C. acuta* with *C. aquilina*, there being a marked approach towards the shape of the anterior end of *C. subconstricta* and *C. aquilina;* and there is also to be noted in the former a slight degree of obliquity to the long axis of the shell in the lines of growth.

M'Coy laid great stress upon the presence of an obtuse angle along the dorsal

margin, and suggested that the *Unio tellinarius* of Goldfuss and de Koninck, which is also stated to possess this character, may belong to Sowerby's species.

The only specimen showing the hinge-character of this species is in the Woodwardian, and I have been allowed to figure it and other specimens from that collection by the kindness of Professor McKenny Hughes (Pl. VI, fig. 44). In the drawing the fragment is looked at from below, and shows the lower edge of the hinge-plate, which is non-articular, the upper part of the plate being in consequence foreshortened.

This fragment shows a total absence of any prominence which can be constructed into an anterior lateral tooth; but there is a sloping surface continuous above the striated lunule, which becomes thickened and raised, immediately below the umbo, into an oblique posteriorly diverging cardinal tooth. Immediately posterior to it is a pit, so that the tooth in the right valve is immediately in front of that in the left valve; the pit in the right valve has a plain triangular surface, and there is no evidence of any posterior lateral tooth.

M'Coy states (p. 515, *op. supra cit.*), " Casts show the thick cardinal tooth, and slender, elongate, lamellar lateral teeth." I am unable to understand this statement, as I cannot conceive it possible for the cast of a bivalve shell, the valves being in their natural position, to show anything of the sort. The Professor evidently mistook the groove left in casts on each side of the middle line by the lower edge of the hinge-plate, both anteriorly and posteriorly, to represent anterior and posterior lateral teeth. I have made a series of plaster casts of *Unio tumidus*, which have definite lateral lamellar teeth, but can obtain no indication of them in the casts.

This shell does not appear to have a very wide distribution. I only know of the above-mentioned localities where it occurs; and it appears to be confined to the horizon of the Low Moor Ironstone beds.

The large specimens, figured Pl. VII, figs. 11 and 15, belonging to Mr. George Wild, of Bardsley, are from the Fullege Colliery, Burnley, and at about the horizon of the Thin bed.

7. Carbonicola obtusa, sp. nov. Plate VII, figs. 16—23; Plate XI, figs. 1, 2.

Specific Characters.—Shape variable, but more or less subquadrate and flattened. The anterior end is moderately convex, short but deep in a dorso-ventral direction; its border circularly rounded. The inferior border is rounded in front, becoming almost straight posteriorly. The posterior part of the shell is narrowed from above downwards by the slope of the upper border, which leaves a long, bluntly rounded or truncate posterior border.

The umbones appear to rise gradually from the whole surface of the shell, and are blunt, raised above the hinge-line; excavated anteriorly, and thinned internally by the encroachment of the lunule, which is moderately deep, widens anteriorly, and is roughly marked by striæ continuous with the lines of growth which pass into it from the surface of the shell. The external ligament is prominent and erect, extending half the way from the umbones to the posterior end. The hinge-line is slightly arched. Hinge-plate triangular as in *C. acuta*, the normal form; but, owing to the more quadrate and stumpy form of the shell, this part of the plate, posterior to the cardinal tooth, is placed at an obtuse angle to the anterior portion.

Valves compressed with an almost obsolete, broad, oblique sinus, most apparent at the lower border. The posterior slope is dilated and obtuse. Shell thick. Muscle-scars normal.

The surface is rough with coarse lines of growth. Periostracum thick and much wrinkled.

Dimensions (Pl. VII, fig. 18):

Antero-posteriorly	35 mm.
Dorso-ventrally	25 mm.
Laterally	16 mm.

Localities.—The roof of the Ten-foot Coal, and the horizon of the Cockshead Rock, Hulme Colliery. Ivy House Colliery, Bucknall. Whitfield Colliery. All in the Lower Coal-measures of North Staffordshire; Middle Coal-measures of Oldham.

Observations.—The form of this species appears to be less variable than most; and although fig. 22, Pl. VII, appears to differ in form from the others, it will be noted that the shell is imperfect at the posterior-inferior angle.

Since having the plates printed I have lifted fig. 16, Pl. VII, from the matrix, and cleaned out the hinge-plates, finding them to be exactly on the plan of that shown in Pl. V, fig. 1. I have not been able to get at more than two interiors, but these do not vary at all. On Pl. XI, fig. 1, is the figure of the hinge-plate of fig. 16, which will be of interest, as it is very rarely that the hinge-plates of two opposing valves can be studied.

The lines of growth are more rough, irregular, and deeper cut than in other forms; and this point, taken in connection with the shape, will serve as diagnostic in determining the species.

This species occurs at only one horizon in the North-Staffordshire Coal-field, but in great abundance, whole beds being made up of it. It is rare in certain places to find the valves in contact, showing that the shells were probably washed into little bays after death. In these places are to be found occasionally a pair of valves opened out as in Pl. VII, fig. 16.

8. Carbonicola nucularis, sp. nov. Plate VII, figs. 24—42; Plate IX, fig. 11; Plate XI, figs. 14 and 16.

Specific Characters.—Shell produced transversely in adults, moderately gibbous, evenly convex, more so comparatively in young forms. Anterior end short, about one-fourth of the whole shell, with a regularly curved border meeting the hinge-line above at an angle, but passing into the inferior border with a regular curve. Inferior border broadly curved in its anterior half; then becoming straight and slightly sinuous. Posterior border bluntly rounded; in older forms the junction with the inferior border is somewhat angular. Hinge-line apparently slightly arched, due to the meeting of the anterior and posterior parts at an obtuse angle. The posterior end is regularly and evenly compressed into its lower and posterior borders; but above the posterior-dorsal slope is expanded, subcarinate, and slightly concave above. Umbones obtuse and blunt, remote, varying slightly in position, never central, somewhat raised above the hinge-line; lunule small. Hinge-plate narrow; the anterior and posterior parts meet at a very wide angle. In the right valve there is a small cardinal tooth just posterior to the umbo, with a pit behind it, Pl. IX, fig. 11. The posterior part of the plate is a narrow ledge, with a groove above it for the ligament. Interior normal. Internal surface very smooth, marked on the posterior slope by radiating lines.

Surface in the two testiferous forms marked with very faint concentric lines of growth. Periostracum much wrinkled.

Measurements :

	Antero-posteriorly.	Dorso-ventrally.	Laterally.
	28 mm.	17 mm.	11·5 mm.
Medium forms	20 „	14 „	10 „
Young forms	16 „	12 „	9·5 „

Localities.—England: Hard-mine roof, North Staffordshire. Mountain Mine, Wigan. Doe Hill, Nottingham. Leicester Coal-field. Coal-measures, South Wales. Scotland: Limestone-Shale, Dunfermline.

Remarks.—There is some resemblance between the species under description and the figure given by Mr. R. Etheridge, jun., in the 'Quart. Journ. Geol. Soc.,' vol. xxxiv, pl. ii, fig. 20, under the name of *Anthracosia ? nucleus* (Brown ?), but he states that the specimen was too imperfect to give a description of it. It was from the original locality of Captain Brown's *Unio* and *Pachyodon nucleus*, the description of which differs only from my form in the fact that it is said to possess a posterior end elongated and acute, whereas I have never found a specimen which can be considered to be acute. Mr. Etheridge, jun., considered it probable that Brown's shell was identical with one form of Rhind's *Axinus Pentlandicus*, 'Age

of the Earth,' pl. ii, fig. A. I have unfortunately not been able to see any specimens from the given Scotch localities, and therefore cannot state anything about the probable nature of the shell, and I have thought it best to invent a new term for the species under notice. I have had the pleasure of examining two specimens, which I here name *C. nucularis*, from Dunfermline, in the Braidwood Collection of Dr. Hunter, although they are somewhat different from my other examples. As far as I know, the species has a limited horizontal and vertical range, and I can only quote three localities. In the Hard-mine roof in North Staffordshire, whence I have obtained about fifty specimens, it occurs with *C. aquilina*, *Anthracomya Williamsoni*, and three forms of *Naiadites*, and in about the same proportion as *A. Williamsoni*, both being markedly less frequent than the associated shells.

I have figured a series from this bed in order to show the amount of variation which occurs. All my specimens have been gathered in about one square mile, with the exception of figs. 30 and 31, Pl. VII.

The blunt posterior end seems characteristic. This form is not met with of greater size than fig. 25, Pl. VII; and specimens as large as this are by no means common. If the hinge-line be carefully examined in many, there will be noted a slight S-shaped curve between the umbones, indicating cardinal teeth, the curve showing the right cardinal tooth to have been anterior. This sinuation is so very slight that in some shells it may be easily overlooked. I have never found any testiferous specimens in the south-east end of the coal-field. The two figs. 30 and 31 come from beds of the same horizon at Talk-o'-th'-Hill. I was fortunate enough, among the specimens from the Mountain Mine of Wigan, sent me by Mr. Waring, to find one in which the valves had slipped, so that the anterior part of the hinge-plate was seen. I did not think it necessary to figure it, as I had before figured specimens showing the normal plan of the hinge apparatus, Pl. V, fig. 1, as it occurs in *C. acuta*.

The specimens from Wigan and Leicestershire show very fine lines of growth indeed, and the same condition is very apparent (in the testiferous specimens figured) beneath the much-wrinkled periostracum.

In the Cardiff Museum I have noted a series of four which retain the shell and periostracum. They are truncate forms, like those figured in Pl. VII, figs. 36, 40, and 41. Unfortunately the horizon at which they occurred in the South Wales Coal-field is not stated.

The shell is more tumid and regularly swollen for its size than any other form, and the umbones are lower and less pronounced.

9. Carbonicola gibbosa, sp. nov. Plate VIII, figs. 1, 1 *a*, 1 *b*, 2.

Specific Characters.—Shell massive, very gibbous, somewhat oblique. Anterior end short, swollen, and deeply excavated above by the lunule, so that it is almost bluntly pointed. The posterior end comprises most of the shell, and is very tumid, becoming gradually compressed toward the posterior end into the border. This end is curved obtusely and rapidly downwards from the end of the hinge-line to meet the inferior border at a blunted angle, which would be a right angle were it not rounded. Inferior border very slightly convex for the greater part of its length, becoming slightly concave posteriorly.

The hinge-line, if produced anteriorly, would form a very acute angle with the inferior border, and is somewhat arched and comparatively long. The external ligament extends nearly to the posterior end of the hinge-line. The umbones are very gibbous and obtuse; with the beaks curved forwards and downwards, contiguous, raised above the hinge-line, and excavated anteriorly by a deep and broad lunule, which is heart-shaped. Surface covered by concentric lines of growth and striæ, which are oblique to the long axis of the shell. Interior not seen.

Dimensions:

Antero-posteriorly	45 mm.
Dorso-ventrally	32 mm.
Laterally	31 mm.

Locality.—Shale above the roof of the Moss Coal, Longton.

Observations.—The only other form of *Carbonicola* which approaches the one under description is *A. turgida*, of which it is quite possible that it may be a very large variety. The lunule of the species under description is comparatively wider and deeper. I only know of two specimens of the shell. From the cabinet of Mr. J. Ward, of Longton, who obtained them from the roof of the Moss Coal, North Staffordshire Coal-field. This shell must be very rare indeed.

Fig. 1, Pl. VIII, is a very perfect specimen, and I have given three views of it.

Fig. 2, Pl. VIII, is a less perfect form, and has been somewhat crushed.

10. Carbonicola subrotunda (*Brown*). Plate VIII, figs. 3—7.

Pachyodon subrotundus, *Brown*. Ann. Mag. Nat. Hist., 1843, vol. xii, pl. xv, fig. 8.
Unio subrotundus, *Brown*. Fossil Conchology, 1849, pl. lxxiii, fig. 22.
Pachyodon Dawsoni, *Brown*. Ann. Mag. Nat. Hist., 1843, vol. xii, pl. xv, fig. 10.
Unio Dawsoni, *Brown*. Foss. Conch., 1849, pl. lxxiii, fig. 3.
? — — *Garner*. Nat. Hist. Staffordshire, 1844, pl. e, fig. 20.

Specific Characters.—Shell subrotund, tumid ; the anterior part almost equal to the posterior in size. Anterior, inferior, and posterior borders rounded; its posterior inferior angle less regularly curved than the rest of the margin. Umbones central or slightly subcentral, tumid, obtuse, separated and raised above the hinge-line, which is slightly arched, with the convexity upwards. Lunule distinct and elongated. Ligament external, nearly as long as the posterior part of the hinge-line. Surface with concentric striæ and lines of growth. Periostracum thick and much wrinkled. Interior unknown.

Dimensions :

Antero-posteriorly	31 mm.
Dorso-ventrally	23 mm.
Laterally	21 mm.

Localities.—Banbury Seam, Adderley Green, Longton, North Staffordshire. Oldham; Lowmoor, Bradford; Wednesbury Oak.

Observations.—The figures of *Unio* and *Pachyodon Dawsoni* (Brown) are very characteristic of entire specimens of this shell; those of *U.* or *P. subrotundus* are typical of crushed forms, giving rise to the appearance of alæ on each side, and forcing the umbo to one side or other.

The form is very characteristic, and seems to vary less than any other species of this genus. I consider it to be a rare form; and, although Captain Brown quotes the occurrence of this species from Lowmoor and Oldham, I have not met with any specimens except in North Staffordshire, neither have I come across examples in any museum.

The figured specimens all show much wrinkling of the periostracum, which was probably, therefore, very thick. I have several other specimens from the same locality, but they are much crushed, and when in this condition resemble Brown's figure of *Unio Dawsoni.* I have adhered to the name "*subrotunda,*" as the figure by which *U. subrotundus* is represented is one of a much more perfect specimen than that of *U. Dawsoni.*

11. Carbonicola turgida (*Brown*). Plate VIII, figs. 8—25.

Pachyodon turgidus, *Brown.* Annals Mag. Nat. Hist., vol. xii, 1843, p. 394, pl. xvi, figs. 13, 14.
— dubius, *Brown.* Ibid., p. 392, pl. xvi, fig. 5.
— similis, *Brown.* Ibid., p. 393, pl. xvi, fig. 12.
— Blaydsii, *Brown.* Ibid., p. 394, pl. xvi*, fig. 2.
Unio turgidus, *Brown.* Fossil Conchology, 1849, p. 178, pl. lxxiii, figs. 10, 17.
— dubius, *Brown.* Ibid., p. 177, pl. lxxiii, fig. 13.
— similis, *Brown.* Ibid., p. 178, pl. lxxiii, fig. 9.
— Blaydsii, *Brown.* Ibid., p. 178, pl. lxxiii, fig. 2.

CARBONICOLA TURGIDA, *M'Coy.* British Palæoz. Foss., 1854, p. 516.
ANTHRACOSIA OVALIS, *Salter.* Memoirs Geol. Surv. Great Britain, Iron Ores, &c., 1861, pt. 3, p. 226, pl. ii, figs. 22, 22 *a*.
— CENTRALIS, *Ward.* Transact. North Staffordsh. Instit. Min. Mech. Engineers, vol. x, 1890, p. 126, pl. i, fig. 16.

Specific Characters.—Shell obliquely and obtusely oblong, very gibbous. The anterior end, situated below the level of the umbones, has a rounded anterior superior angle and an obtusely rounded border, passing by a gradual curve into the inferior border. The anterior part of the shell is small and compressed at the border, but swelling rapidly. The posterior end forms the greater part (about two-thirds) of the shell, and it becomes compressed above into the hinge-line and border. The posterior border is obliquely truncate with an obtuse angle. Ventral margin nearly straight. Hinge-line straight, about half the total length of the shell, oblique to the long axis of shell. Umbones situated about the centre of the hinge-line, large, obtuse, contiguous. Lunule elongate and narrow. Ligament external and short. The edges of the valves posterior to the ligament are bevelled at the expense of the upper border, forming an elongated V-shaped trench. Valves very tumid, more so anteriorly, becoming gradually flattened posteriorly, marked with fine concentric striæ and lines of growth, often slightly oblique to the long axis of the shell, also very fine radiating striæ. Interior very smooth. Muscle-scars: anterior-adductor scar circular and shallow, almost marginal; accessory pedal-scar above it. The posterior-adductor scar is ovately triangular, situated high up near the posterior superior angle of the shell. In the right valve the lower edge of the anterior portion of the hinge-plate is bevelled and facetted at the expense of its lower border, and above this is a slight horizontal ridge, which is the inner edge of the lunule. The lunule terminates in a ridge directed obliquely backwards and downwards, which is the cardinal tooth, and behind it is a pit for the reception of the cardinal tooth of the left valve. Posterior to this pit the hinge-plate is thickened into a boss, forming a second cardinal tooth. The rest of the hinge-plate is flat and smooth.

Dimensions:		Scotch specimen.
Antero-posteriorly . .	37 mm.	43 mm.
Dorso-ventrally . .	23 mm.	30 mm.
Laterally . . .	18 mm.	20 mm.

Localities.—England: Stubbs' Mine, Bardsley, Coalbrookdale. Grain's Ironstone, Farthing Lane, Dudley. Roof of the Moss Seam, North Staffordshire. Stanley Main and Shale Coal, Wakefield. Wales: Two feet above bottom vein, Gantre, Ebbw Vale, South Wales. Scotland: Dallmellington, Lurgar. Splint Coal, Wishaw Coal-measures. Upper Coal-measures, Cambuslang and Shettleston.

Observations.—Captain Brown, who first described this form, gave two very

good figures (*op. supra cit.*), but in this same paper described, under the names of *Pachyodon dubius* and *P. similis*, two shells which I consider to belong to the same species. His figure of *P. dubius* resembles the specimen I have figured on Pl. VIII, fig. 17, from the collection of Dr. John Young, and which I regard as a young example of this species.

The description given by M'Coy is very accurate and striking. He states that "this species is easily distinguished from all others by its short quadrate form and evenly gibbous, very tumid valves." This form does not appear to have been recognised by Mr. Salter; for he figures a specimen of it (*op. supra cit.*), under the name of *Anthracosia ovalis* (Martin), which shows not the slightest resemblance to Martin's original figure.

Mr. Ward figures a somewhat imperfect specimen from the roof of the Moss Coal (*op. supra cit.*) under the name *Anthracosia centralis*, but it has the tumid prominent umbones of the species under notice. I have figured a number of crushed and smaller forms from this bed, which may be young of *C. turgida*, Pl. VIII, figs. 21—25. The peculiar shapes in these cases are due to crushing-in of the lower edges of the shell and separation of the valves, but they all possess the characteristically shaped posterior slope and prominent tumid umbones. This species is not at all common, and where it occurs has a very small vertical range; but it seems to have had a wide horizontal distribution. It is one of the most elegant of the Coal-measure shells when perfect; but it is often difficult to recognise when crushed. The form, too, is fairly constant; but it will be observed that the obliquity of the striæ so marked in some specimens (Pl. VIII, figs. 8, 12, and 18) is not always present; figs. 10, 13, 19, and 20 showing an almost perfect concentric arrangement. Whether this variation is due to locality I cannot say, but all the specimens which have come into my hands from Coalbrookdale and most of those from North Staffordshire are not obliquely grown. Most of the Scotch forms appear as casts.

The form is closely allied to *C. gibbosa*, which perhaps may be only a giant variety; but there are certain differences, which have induced me to separate the two forms.

The cast of the hinge-line, fig. 15 *a*, Pl. VIII, indicates by the S-shaped flexure between the umbones the presence of cardinal teeth.

The name *turgida* has been adopted because the shells figured by Captain Brown under this term are more typical than those figured under those names which I have regarded as synonymous.

12. CARBONICOLA AQUILINA, *Sowerby*. Plate V, fig .2; Plate IX, figs. 1—10, 12—37; Plate X, figs. 1—42; Plate XI, figs. 31—33.

UNIO (no specific name), *Ure*. Natural History of Rutherglen, 1793, pp. 310, 311, pl. xvi, fig. 4.
— AQUILINUS, *Sowerby*. In Prestwich, J., On the Geology of the Coal-field of Coalbrookdale (read April 27th, 1836), Trans. Geol. Soc. London, ser. 2, vol. v, 1840, pl. xxxix, fig. 12.
— PHASEOLUS, *Sowerby*. Ibid., pl. xxxix, fig. 11.
— ATRATUS, *Goldfuss*. Petrefacta Germaniæ, livr., 1837, p. 180, pl. cxxxi, fig. 16.
PACHYODON LATERALIS, *Brown*. Ann. and Mag. Nat. Hist., 1843, p. 391, pl. xv, fig. 3.
— SULCATUS, *Brown*. Ibid., p. 391, pl. xv, figs. 4 and 5.
— BIPENNIS, *Brown*. Ibid., p. 391, pl. xv, fig. 9.
UNIO LATERALIS, *Brown*. Fossil Conchology, 1849, p. 177, pl. lxxiii, fig. 26.
— BIPENNIS, *Brown*. Ibid., p. 177, pl. lxxiii, fig. 27.
— SULCATUS, *Brown*. Ibid., p. 177, pl. lxxiii, figs. 28, 29.
— AQUILINUS, *Brown*. Ibid., p. 181, pl. lxxviii, fig. 23.
— PHASEOLUS, *Brown*. Ibid., p. 181, pl. lxxviii, figs. 21, 22.
ANTHRACOSIA BEANIANA, *King*. Ann. and Mag. Nat. Hist., 1856, ser. 2, vol. xvii, p. 54, pl. iv, figs. 1, 2.
UNIO SECURIFORMIS, *Ludwig*. Palæontographica, Band viii, 1859, p. 33, pl. iv, figs. 1—9.
ANODONTA PROCERA, *Ludwig*. Ibid., p. 36, pl. v, figs. 9, 10.
— CICATRICOSA, *Ludwig*. Ibid., p. 35, pl. v, figs. 7, 8.
UNIO CRASSIDENS, *Ludwig*. Ibid., Bd. viii, 1861, p. 184, pl. lxxi, figs. 15—17.
ANTHRACOSIA AQUILINA, *Salter*. Mem. of the Geol. Survey of Great Britain, Iron Ores of South Wales, pt. 3, 1861, pl. ii, fig. 17.
— ÆQUILINUS, *Hull*. Coal-fields of Great Britain, 1873, pl. i, fig. 5.
— SECURIFORMIS, *Koenen*. Zeitsch. Deutsch. Geol. Gesell., vol. xxxiii, 1881, p. 686, pl. xxvi, figs. 6 and 7.
Non — AQUILINA, *Ward*. Trans. North-Staff. Inst. Mining and Mech. Engineers, vol. x, 1890, p. 128, pl. i, figs. 5 and 14.
— BEYRICHI, *Achepol*. Niederrheinisch.-Westfälliche Steinkohlen Gebirge, Atlas, 1880–83, p. 60, Blatte xvii, figs. 4, 20; Supplement, iii, figs. 17—21.
— SERLOI, *Achepol*. Ibid., p. 84, cuts 1 and 2; Supp. iii, figs. 23—29.
— LOTTNERI, *Achepol*. Ibid., Supp. iv, fig. 4.
— DECHENI, *Achepol*. Ibid., Supp. iv, figs. 8—10.
— HAUCHECORNEI, *Achepol*. Ibid., Supp. iv, figs. 13, 15.
— BERENDTI ?, *Achepol*. Ibid., Supp. iv, figs. 47, 48.
— RÖMERI, *Achepol*. Ibid., Supp. iv, figs. 79, 80.

Specific Characters.—Shell transversely ovate, flattened and compressed, variable. Anterior end rounded, compressed, and small, its upper border being at

a lower level than the rest of the shell. The inferior border, convex anteriorly, soon becomes almost straight. The posterior part of the shell is produced, uniformly tumid, and is hardly compressed till near the borders. The posterior border may be rounded or obliquely truncate from above downwards, or almost pointed. The upper borders of the valves are flattened and expanded, so that the greatest convexity of the shell is on a level with the hinge, this rendering the posterior slope very blunt and angular.

The umbones are anterior, slightly everted, obtuse, with the apices directed forwards and remote. They rise in front by a well-marked curved fold which has a well-defined edge, and takes its origin from the surface of the valve below the upper edge of the valve, which appears to be compressed anteriorly to and above the fold. Posteriorly the umbones pass into the posterior slope very gradually. The hinge-line is below the level of the upper surface of the valves, and each valve is channelled above by a longitudinal groove which lies between the hinge-edge, which is compressed and raised upwards, and the posterior umbonal slope. These grooves are well marked in casts. The external ligament is inserted into the bottom of these grooves, where the fibres appear to be continuous with the lines of growth, as they turn over the upper border of the shell and dip into the groove.

The surface is marked by fine or coarse lines and striæ of growth, markedly oblique in their arrangement to the long axis of the shell and eccentric. These striæ are crowded and very convexly curved at the anterior end, but they gradually become further apart and almost straight till they are rapidly reflected at an angle over the umbonal slope, when they become directed forwards and inwards. The surface is often subsulcated.

The hinge-plate consists of two portions which are placed at an angle with each other, the direction of the anterior part being upwards and backwards, and that of the posterior part almost horizontal, but there is no plate of shell connecting the two portions. I quote King's original description of the hinge apparatus :— " Teeth, one in each valve below (and anterior to) the umbo, rather low and massive ; crown of tooth of right valve excavated anteriorly (and below) and ridged posteriorly ; crown of tooth of left valve ridged anteriorly and sloped posteriorly." These teeth may be facetted. The posterior part of the hinge-plate joining the anterior part at an acute angle is flattened, or sometimes rounded, and excavated as in Anodon for the posterior terminal attachment of the external ligament, and ultimately is lost on the inner surface of the shell.

Above the hinge-plate is a longitudinal groove formed by the curving round and terminating of the lines of growth, which serves for the lateral attachment of the ligament.

Interior.—The anterior-adductor scar is almost marginal, the front part being

deep and smooth; the hinder gradually becomes more shallow, and is rough and subdivided by numerous irregularly branching lines. The anterior accessory pedal scars are small, pit-like, and situated immediately behind the posterior-superior angle of the anterior adductor.

The posterior-adductor scars are shallow, somewhat broader posteriorly than anteriorly, situated within the posterior slope close to the hinge-line, and not far from the posterior end. The position of both adductor muscles is often indicated on the exterior of the shell by marked depressions due to muscular strain.

Casts indicate a longitudinal groove between the umbones and the hinge-edge, Pl. X, figs. 19 *a*, 20 *a*, 21 *a*, and a broad, deep excavation anterior to the umbones for the hinge-locking teeth, crossing which the line representing the junction of the two valves becomes sinuously curved, being deviated from before backwards, first to the right and then to the left, demonstrating the presence of cardinal teeth in the valves, of which that in the left is slightly anterior to that in the right. There is always posteriorly a raised central ridge corresponding to the interval between the hinge-plates, which shows that the "posterior elongate lamellar teeth" of M'Coy and Amalizky are absent. The surface of casts is marked by broad, shallow, eccentric sulci, and often with obscure radiating lines.

Dimensions:	Antero-posteriorly.	Dorso-ventrally.	Laterally.
Pl. IX, fig. 6 .	45 mm.	18 mm.	14 mm.
Pl. X, fig. 5 .	40 mm.	16 mm.	10 mm.
Pl. IX, fig. 1 .	30 mm.	15 mm.	10 mm.

Observations.—This species is by far the most common form in British coal-measures, both in its vertical and horizontal range, and it also occurs in many localities abroad, in Belgium and Germany, a fact which is well attested by the list of synonyms. The shell is very variable indeed in shape, size, and also in the strength of the surface striæ; but I have not been able to convince myself of the necessity of giving varietal names, from the study of large numbers of shells belonging to this species from the same and different beds. I find that all forms are met with in the beds at Whitley, Northumberland, the Hard Mine, North Staffordshire, and the Grain's, Gubbin, and Brooch Ironstones, South Staffordshire, showing, I think, by the presence of all the extreme forms and complete series of intermediate ones, that they were all fertile *inter se*.

The hinge characters appear to be constant, and to bear out Professor King's observations (*op. supra cit.*), and I have met with no variation except that of degree in the form of the hinge.

It is important to note that abroad Ludwig, Amalizky, and others have mistaken the sharp superior edge of the posterior part of the hinge-plate with the groove

for the insertion of the ligament parallel to it, for the elongate lamellar teeth of M'Coy, which are not indicated in casts, and are characteristically absent in the hinges of *C. aquilina,* which I figure Pl. IX, figs. 5, 9, 12—14. In the many fragments exhibiting all parts of the hinge-plate which have passed through my hands I have never observed any indications of lateral teeth, my experience completely coinciding with Professor King's original observations on this point.

The diagnostic features on which I have relied for the identification of this species are the shape of the anterior end and the umbones, and the obliquity of the lines of growth, taken together with the wedge-shaped, flattened form of the sides of the valves and the broadly channelled upper border, characters which are well shown in Sowerby's original figure in Professor Prestwich's 'Geology of Coalbrookdale.'

It is quite possible that the original of Ure's shell may have belonged to the species under discussion, but the shell itself is lost. The characteristic oblique lines of growth are indicated in his figure, and Dr. John Young, of the Hunterian Museum, Glasgow, showed me a specimen from the original locality which was certainly *C. aquilina.* Fleming, however, who was responsible for the name *Unio Urei*, Ure having unfortunately omitted any description of his form, describes, in his 'History of British Animals,' the shell *Unio Urei* as follows :—" Transversely oblong, dorsal margin nearly straight, unequally striated by lines of growth ;" but he considered that this shell was synonymous with Martin's *Mya ovalis*, which exhibits none of the characters of *C. aquilina.* In addition Ure's shell has been erroneously referred to *Sanguinolites* by Sowerby (Prestwich, 'Geol. of Coalbrookdale,' *vide supra*, pl. xxxix, fig. 6); I say erroneously, because several Scotch geologists inform me that no marine forms ever occur in Ure's original locality. After all, on account of the confusion attaching to the history of Ure's shell, I have thought it advisable to adopt Sowerby's specific name of *aquilinus* in place of the doubtful reference to Ure. I believe that Goldfuss's *Unio atratus* and possibly his *U. tellinarius* may belong to Sowerby's species ; the former has the characteristically shaped anterior end, but the oblique lines of growth are not shown, and the latter is crushed. A series of specimens, however, from the neighbourhood of Liége, which I examined at Liége, Brussels, and the British Museum (Nat. Hist.), labelled with these names, convinced me that the species were identical. I have been in doubt as to the question of priority between Sowerby's *aquilinus* and Goldfuss's *atratus.* Bound copies of 'Petrefacta Germaniæ' bear the date 1840, but the work came out in parts, commencing 1836. This coal-measure shell appears on pl. cxxxi, and its description at p. 180 was issued in the *livraison* dated "1837". Prof. Prestwich's 'Geology of Coalbrookdale' was published in 1840, and Sowerby's description of coal-measure shells was issued as an appendix to it; but the paper was read before the Geological Society on

February 5th, 1834, and on April 13th and 27th, 1836. The Assistant-Secretary, Mr. L. Belinfante, B.Sc., has kindly looked up the original minutes of these Meetings, and he finds with regard to the Meeting on February 5th, 1834, the following entry:—"The author concludes his memoir with some observations on the fossils . . . of 18 genera of shells which he enumerates; 12 are marine." In the minute for April 27th, 1836, is found—"The fossils of the coal-measures are described with great detail." This evidence I take to be conclusive as to the priority of the name *aquilina* over *atrata*. I endeavoured to obtain accurate information as to the character of Goldfuss's shells, but Professor Schlüter of Bonn, where the originals are said to have been placed, writes me that they have either disappeared or are so fragmentary as to be unrecognisable.

I have come to the conclusion that the shell figured by Sowerby as *Unio phaseolus* is only a very young form of *C. aquilina*. The original figure agrees very closely with the shell figured on Pl. X, 19 to 42, a series of casts intended to show stages of growth, from the roof of the Hard Mine seam, North Staffordshire, in which bed the shell occurs in hundreds, the majority of the specimens being casts of perfect examples. Its anterior end is shown to be very small in the original figure, a condition which is shown specially in Pl. X, figs. 26, 33, 40. There can be, I think, little or no hesitation in referring Captain Brown's three species, *Pachyodon* or *Unio lateralis*, *bipennis*, and *sulcatus*, to *C. aquilina*. The figures of *Pachyodon* and *Unio lateralis* are those of a cast which shows the characteristically shaped anterior end, and are closely resembled by Pl. X, fig. 36. The figures of *Pachyodon* and *Unio sulcatus* show the obliquity of the lines of growth and anteriorly directed umbones, and agree in general shape with the deeper forms of *C. aquilina*, Pl. X, figs. 15, 16, 17, and 20, from Whitley; but the figures of *Pachyodon* and *Unio bipennis* have the characteristic features of *C. aquilina*, and evidently belong to that form which possesses a blunt truncated posterior end, as Pl. IX, figs. 2, 3, and 31; Pl. X, figs. 20 and 23.

Professor King says, in his remarks on his new species *Anthracosia Beaniana*, "This species has some resemblance to Brown's *Pachyodon bipennis*, but it differs from the latter notably in the anterior end being much shorter," a character which a study of my figures on Pls. IX and X will show not to be of specific value. The description is very meagre, consisting of "Diagnosis: Oval, very inequilateral. Umbones small; valves thin, rather tumid, and marked with nearly obsolete wrinkles," which, unfortunately, gives no very definite characteristics. Figures only of the inner surface of the shell are given; but in these the obliquity of the lines of growth curving over the posterior slope into the groove along the edge of the valve are markedly shown. The originals cannot be traced, unless some fragments in the Science Museum, Newcastle-on-Tyne, which Mr. Howse tells me are labelled in Professor King's handwriting, represent them. One of these

fragments is that of *C. aquilina*, showing the characteristic hinge-plate, which is the form described by Professor King as occurring in *A. Beaniana.* This hinge-plate has been necessarily modified from that occurring in other species of the genus by the obliquity of the growth of the shell, and is anything but characteristic of the genus,—in fact, I believe, from my observations, that it is peculiar to the species *C. aquilina.* I made a special visit to the shell-bearing beds at Whitley, whence Professor King obtained his original specimens, and was able to bring away with me about 100 specimens, some of which I have figured, Pl. IX, figs. 10—24, a series which shows the variable character of the shell. From a personal study of Ludwig's original specimens, kindly permitted me by Professor Geinitz at Dresden, I have no hesitation in saying that his *Unio securiformis*, *Anodonta procera*, *A. cicatricosa*, and *Unio crassidens* are synonymous with Sowerby's *C. aquilina*, and to this list Achepol has added no less than seven.

Koenen's figures of *Anthracosia securiformis* are certainly typical of the species under discussion. This author states that the originals of his figures are in the Museum of Berlin. If so, there is no label to note that the specimen has been figured, but I fully believe I saw the specimen there when I was permitted by the authorities to study all the Coal-measure bivalves. The specimens in the Berlin Natural History Museum labelled *A. securiformis* are certainly the same as those I am figuring as *C. aquilina*, but they are very large forms, and have the edge of the cardinal tooth facetted.

Large forms are rare in England, but I figure one which occurred to me in the roof of the Hard Mine at Hulme Colliery, Adderley Green, on Pl. XI, fig. 31; but this is the only one which I have seen to attain these dimensions.

The shells figured by Mr. John Ward, F.G.S. (*op. supra cit.*), possess none of the specific characters of *C. aquilina*, and should, I think, be referred to *C. acuta.* Mr. Ward has handed to me for figuring some shells of *C. aquilina* which have several small circular holes scattered over them. These holes are so regular in shape that they can scarcely have been due to erosion by plants, and so many that the probability of the cause being due to boring by some gasteropodous mollusc may be set aside. The edges of the apertures are everted, and it has occurred to me that they may have been due to the bursting through the periostracum of bubbles of CO_2 gas due to decomposition (?). Figures of two of these shells are given on Pl. XI, figs. 32 and 33.

The shell figured by Mr. Salter (*op. supra cit.*) as *Anthracosia aquilina* is very characteristic in shape and excellently drawn, showing the specific details very accurately. It is less elongated transversely, and has a comparatively greater dorso-ventral measurement than obtains in the type, and thus is more akin in shape to the form called by Professor King *Anthracosia Beaniana.*

Localities.—England: Banbury; Hard Mine, Bowling-alley Seam; roof of

Moss Coal, N.-Staff. Field; Blue Flats, Coalbrookdale; Bradford; Grains Ironstone; Brooch Ironstone; Gubbin Measures, Foxyard; Dudley, S. Staffs; Radstock;[1] Whitley, shale above Lower Main Coal, and Newbiggin; Cannock Chase; Netherton, near Morpeth, above high main seam; Horsley Wood, Wylam; 17 feet below Bensham seam; 5 feet 4 inches seam, Heworth; Beaumont seam, Newcastle-on-Tyne; roof of Shale Coal, Stanley Main, Wakefield; New Mine, Bardsley; Stubbs's Mine. Wales: S. Wales, over Four-foot, Hafod; Sychffos; Ynys Cedwin, from the Pennypieces; Bagillt, Hollywell, Flintshire. Many of these localities are copied from labels of specimens in the Museum of the Geological Survey, Jermyn Street. Scotland: Mussel-band, Kilbride; U. C. M., Fullerton, Ayrshire; Eight-foot Coal, Scoonie, Fife.

13. Carbonicola angulata (*de Ryckholt*). Plate XI, figs. 3—5.

Cardinia angulata, *de Ryckholt*. 1850, p. 104, part i, pl. vi, figs. 10 and 11.
Anodonta angulata, *Ludwig*. Päl. Urals, 1863, band x, pl. iii, figs. 9, 9 *a*.
Naiadites angulata, *Dawson*. Acadian Geology, 2nd edit., 1868, p. 243, fig. 46.
Carbonicola angulata, *Hind*. Quart. Journ. Geol. Soc., 1894, p. 441, pl. xx, fig. 14.

Specific Characters.—Shell transverse, small; anterior end rounded, moderately tumid, consisting of about one-third of the shell. The posterior end is obliquely truncate from above downwards, with the upper angle obtuse, and the inferior one rather less than a right angle. The inferior border is almost straight.

The umbones are small, elongate, with their apices pointing slightly forwards, contiguous, and prolonged backwards and downwards in an angular ridge, which terminates in the posterior inferior angle of the shell. They rise in front by a gradual tumidity, concave upwards, commencing at the anterior margin of the shell. The valves are compressed and flattened into the superior and posterior borders above the oblique ridge. Surface marked with fine striæ and lines of growth.

Interiors.—Normal; but no specimens showing the hinge have been met with.

[1] This is the only specimen of molluscan remains which I have seen from the Radstock Coal-measures, and is in the possession of Mr. R. Kidston, of Sterling. It occurs on a piece of shale with plant remains from the Upper Coal-measures of Radstock. At p. 36 of the 'Memoirs Geol. Survey Great Britain,' "The Geology of the East Somerset and Bristol Coal-fields," 1876, is a notice of the occurrence of "casts of bivalve mollusca (*Anthracoptera?*) in the coal-shale at Twerton, on the authority of Prof. Morris; and of "*Anthracosia?*" at Cammerton on the authority of Mr. McMurtrie. Owing to the high position of the beds of this Coal-field, which, according to Mr. Kidston, are the highest in England, the paucity of molluscan remains points to a change in the conditions of deposition from that which obtained in the period of the Middle Coal-measures.

Dimensions:

Antero-posteriorly	20 mm.
Dorso-ventrally	9 mm.

Locality.—Low-bottom Bed, Fulledge, Burnley.

Observations.—From the description and figures of de Ryckholt's *Cardinia angulata* I am inclined to refer the British forms to his species, to which I consider Sir Wm. Dawson's specimen of *C. angulata* from the South Joggins Coal-field also belongs, the specific name *angulata* having been given to it by him independently. I have therefore referred the specimens from Burnley to this species. The English examples, however, are somewhat larger.

I have been able to examine very few specimens of this species, all of which are from Burnley; and I have not met with the form from any other British locality.

It approaches somewhat the next species to be described, *C. similis* (Brown), in the possession of an oblique ridge and the compression above it; but the general shape and dimensions have made me hesitate to refer it to this species, and unfortunately at present no specimens have been found with the valves closed, so that the general shape of the united valves is not known.

14. Carbonicola similis (*Brown*), 1843. Plate XI, figs. 6—13, 15, 17—23, 25—27.

Pachyodon similis, *Brown*. Ann. and Mag. Nat. Hist., vol. xii, 1843, p. 393, pl. xvi, fig. 12.

Unio similis, *Brown*. Fossil Conchology, 1849, p. 178, pl. lxxiii, fig. 9.

Pachyodon nanus, *Brown*. Ann. and Mag. Nat. Hist., vol. xii, 1843, p. 392, pl. xvi, fig. 1.

Unio nanus, *Brown*. Fossil Conchology, 1849, p. 177, pl. lxxiii, fig. 7.

Non Cardinia nana, *de Koninck*. Descript. Carbonif. Anim. Foss. Belgique, 1842, p. 71, pl. i, fig. 6.

Specific Characters.—Shell almond-shaped, transversely oval, slightly oblique; anterior end elliptically rounded; narrow dorso-ventrally. Inferior border regularly convex, not interrupted by a sinus. Posterior end deeper than the anterior, and bluntly rounded in old specimens; but in young forms it is obliquely truncate from above downwards, with a somewhat acute posterior inferior angle. The superior and inferior borders are subparallel.

The umbones are moderately convex, flattened, elongated, low, and contiguous; situated about the junction of the anterior and middle thirds of the shell. They are continued downwards posteriorly to the posterior-inferior angle by a ridge, above which the shell is rapidly compressed into the superior and posterior

borders. This compression in many cases results in a sloping smooth surface, slightly concave from side to side.

The lunule is elongated and narrow. External ligament short and erect.

Valves evenly convex; in some cases flattened, in others more cylindrical. Shell thin. Lines of growth very fine, arranged concentrically. Periostracum thin; much wrinkled and folded towards the circumference of the shell.

Interior.—The posterior adductor-muscle scar is situated along and just above the ridge which passes upwards into the umbo. Hinge-plate as in *C. robusta*, Pl. II, fig. 1 *a*.

Dimensions:

	Pl. XI, fig. 6.	fig. 8.	fig. 9.
Antero-posteriorly .	30 mm.	32 mm.	27 mm.
Dorso-ventrally .	16 mm.	20 mm.	14 mm.
Laterally . .	6 mm.	13 mm.	7 mm.

Localities.—A thin band of ironstone above the Cockshead Rock. Hulme Colliery, Longton. Horizon of Banbury Coal, Bucknall. South-west of Mow Cop on the same horizon. 7-foot—Banbury? (Talk-o'-th'-Hill). All in the lower measures of the North Staffordshire Coal-field. South Staffordshire, above the Brooch Coal. Scotland—Lurgar. Springshill Colliery, Ayrshire.

Remarks.—From the figures and description I have no doubt that the species under notice is that figured by Captain Brown under the names of *Pachyodon* and *Unio similis*, the figures representing an adult form; while in his figures of *Pachyodon* and *Unio nanus* a young form is depicted. From the series of specimens which I figure in Pl. XI, figs. 6 and 7, 9—13, and 15, from the horizon of the Brooch Coal, Dudley, it appears that the characteristic shape of the adult shell is not possessed by the young, although the oblique line passing from the umbones backwards to the lower angle is always present, together with the characteristic compression of the shell above this line. In young shells, however, the posterior end is truncate and the inferior extremity acute; but in process of growth the shell expands upwards and backwards at the posterior superior angle more rapidly than it does below, so that the posterior end becomes expanded in a dorso-ventral direction, and the end of the shell itself becomes bluntly rounded.

There is also at the same time a greater expansion circumferentially, so that the adult shells are much less convex comparatively than the young. These changes by growth account for the fact that Captain Brown made two species of what I consider I have shown to be only one; and, indeed, if it were not that I fortunately was able to study a series of shells in all stages of growth, I have no doubt that I should have separated the adult and young forms into two different groups.

From my observations in the North-Staffordshire Coal-field I consider that

this species may be of value in denoting a definite horizon. I have found it to occur all round the basin, from Hulme Colliery on the south-west, along the outcrop north-east to the foot of Mow Cop, and south-west by Talk-o'-th'-Hill to Halmerend in a bed some little way above the Cockshead Rock. Though found to have a fairly wide horizontal distribution, it does not appear to occur at more than one horizon. Although in no one specimen is the whole of the hinge-plate to be seen, yet, from many specimens where portions of it are to be seen, it appears to have a fairly regular character, resembling that of *Carbonicola robusta*. Portions of the hinge are seen in Pl. XI, figs. 15, 25, and 26.

The figure of *Unio Castor*, Eichwald, 'Lethæa Rossica,' 1855–9, pl. xxxix, fig. 20, somewhat resembles the species under description; but the latter is from beds of Permian age, and I have not been able to compare the shells, so that I cannot say whether the species are the same; but certainly Brown's name has the priority.

Prof. Amalizky ('Palæontographica,' vol. xxxix, "Ueber die Anthracosien der Permformation Russlands," pl. xxii) gives figures of *Naiadites subcastor*, nov. sp., figs. 30—33; *Naiadites Fischeri*, nov. sp., figs. 34 to 39; and *Naiadites Castor*, figs. 40 to 43,—all of which show some resemblance to the adult forms of *C. similis*.

Captain Brown's description is as follows:—"Compressed, anterior side rounded; umbones hardly produced, contiguous; posterior side parallel, obliquely truncate; hinge-line straight, basal line arcuated; surface with transverse wrinkles." Both the shells *Unio similis* and *Unio nanus* are from the same locality—Middleton, near Leeds.

De Koninck gave the specific name *Cardinia nana* to a small fossil which Prof. Geinitz considers to be the same as that figured later on by Ludwig as *Cyclas nanus;* and he states that the fossil in question is an *Estheria*, and proposes that both should be placed in that group under the name of *Estheria nana* ('Neues Jahrbuch für Mineralogie,' &c., 1864, pp. 653–4; see above, p. 17).

Specimens of *Cardinia Scherpenzeeliana* (de Ryckholt, 1850) approach, very closely in form the young of Bronn's species, *e.g.* Pl. XI, figs. 10, 11, 13.

15. Carbonicola cuneiformis, sp. nov. Plate XI, figs. 24, 24 *a*.

Specific Characters.—Shell very oblique, moderately convex, wedge-shaped. The anterior end is small and compressed, but broad above. The shell rapidly becomes swollen in a posterior direction, and after attaining the maximum convexity is gradually compressed into the posterior border.

The anterior border terminates abruptly above, forming a rounded slightly

obtuse angle with the upper border; it then becomes rapidly rounded, the convexity being very acute at the junction with the inferior border, which is sinuously curved, so that the posterior inferior angle of the shell, which is very blunt, is below the level of the rest of the border. The posterior border is convexly truncate. There is a marked shallow, oblique subconstriction, which does not extend far up the shell towards the posterior end. The shell is much broader at its upper border than anywhere else. The umbones are anterior, broad, obtuse, and remote, rising rapidly in front, and posteriorly forming an acute well-marked ridge, which passes down towards the inferior angle, just above which it becomes lost on the surface of the shell.

The posterior part of the shell above this ridge is deeply channelled, the groove becoming wider and shallower as it passes backwards. The lunule is wide and flattened. The posterior ligament appears to be attached to the faces of the hinge-plate.

Interior normal. Exterior: Lines of growth very fine.

Dimensions :

Antero-posteriorly	17 mm.
Dorso-ventrally	10 mm.
Laterally	8 mm.

Locality.—Roof of the Hardmine Coal, Bucknall Colliery, North Staffordshire.

Observations.—I know only two specimens of this species. They are totally different in shape and appearance from any of the other species, and loth as I am to found a species on the occurrence of only two examples in such a variable genus, I have felt that it was impossible to refer the shell to any known form.

16. Carbonicola antiqua, sp. nov. Plate XI, figs. 28—30.

Specific Characters.—Shell moderately tumid, nuculiform, oblique. The anterior end is short and swollen, with an almost circular border. The inferior border is gently convex in front, becoming straight in the posterior two-thirds. Its posterior surface is gradually compressed, with a bluntly truncate end, which may become almost pointed at the inferior angle; the descent of the superior border is at first somewhat rapid, it is flattened above, and terminates outwards in a bluntly rounded ridge which is continuous with the umbo above, and passes downwards and backwards to the posterior inferior angle. The umbones are anterior, depressed, moderately convex, pointed forwards and contiguous. Lunule is well marked and striated. The surface is ornamented with well-marked but fine lines and striæ of growth, somewhat oblique in direction to the long axis of the shell.

Interiors normal.

Hinge-line arched, edentulous, surmounted posteriorly by a longitudinal hollow groove or elongated escutcheon, below which the ligament arises from a faint linear groove on the extreme edge of the shell.

Dimensions (fig. 29):

Antero-posteriorly	25 mm.
Dorso-ventrally	16 mm.
Laterally	12 mm.

Locality.—Calciferous Sandstone Series, Kilminning and Kilrenny Mill, Fife; where it occurs at two horizons, one a hard shell bed in large numbers, the other a siliceous limestone with Littorina (?) Scotoburdigalensis twigs of Lepidodendron.

Observations.—I am indebted to Mr. Kirkby, of Leven, Fife, for the opportunity of studying these shells. They are interesting as occurring very low down in the Carboniferous series, and are probably the oldest form of Carbonicola known if I am right in my determination. Mr. Kirkby tells me that the late Mr. Salter referred them to Anthracosia. In support of this view, the lunule and general shape of the shell are very characteristic of Carbonicola, and I can discover no evidence of the peculiar teeth of Nucula. The shape and obliquity of the lines of growth show a relationship to *C. aquilina*, the shell of greatest range in this group, but the two forms are easily distinguished. I have visited the locality myself this summer and obtained a number of specimens, some of which showed the interior. The accessory anterior adductor muscle scar is above the anterior adductor, as in other members of this genus. The hinge is without cardinal teeth, but there is an approach towards a flattened hinge-plate seen as an expansion downwards of the edge of the shell, more easily seen in casts; the groove for the ligament is apparent, but I have not seen any specimens with the ligament preserved. In the bed at Kilrenny Mill the shell occurs in great numbers though the horizontal distribution seems limited to a few inches, and a mytiliform shell is very abundant, which I expect is the form named by R. Etheridge, jun., *Anthracoptera ? obesa*;[1] but I hesitate to refer it to this genus (Naiadites) because in addition to the striated hinge-plate it possesses a well-marked tooth in the hinge. I would point out that Mr. R. Etheridge, jun.,[2] doubtfully refers a shell from the cement stone group of Craiglockhart Hill, near Edinburgh, to *Anthracosia ? (Unio) nucleus*, Brown, to which I have alluded on p. 63, the original locality being Woodhall, Water of Leith, and it is very possible that it and the species under discussion are the same.

[1] 'Quart. Journ. Geol. Soc,' vol. xxxiv, 1878, p. 12, pl. 1, figs. 12 and 13, (14 ?).

[2] Ibid, p. 16, pl. 2, fig. 20.

PLATE I.

Fig. 1.—*Carbonicola robusta.* From Lower Yard Seam, Fulledge, Burnley. In Mr. George Wild's Collection. (Page 45.)

Fig. 2.—*Carbonicola robusta.* The original of Prof. Prestwich's figure, 'Geology of Coalbrookdale,' pl. xxxix, fig. 14, from his Collection. (Page 45.)

Fig. 2 *a.*—The same specimen viewed from superior border.

Fig. 3.—*Carbonicola robusta.* From Dalmellington, Upper Coal-measures. From Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 3 *a.*—The same, showing the external view of hinge and ligament. (Page 45.)

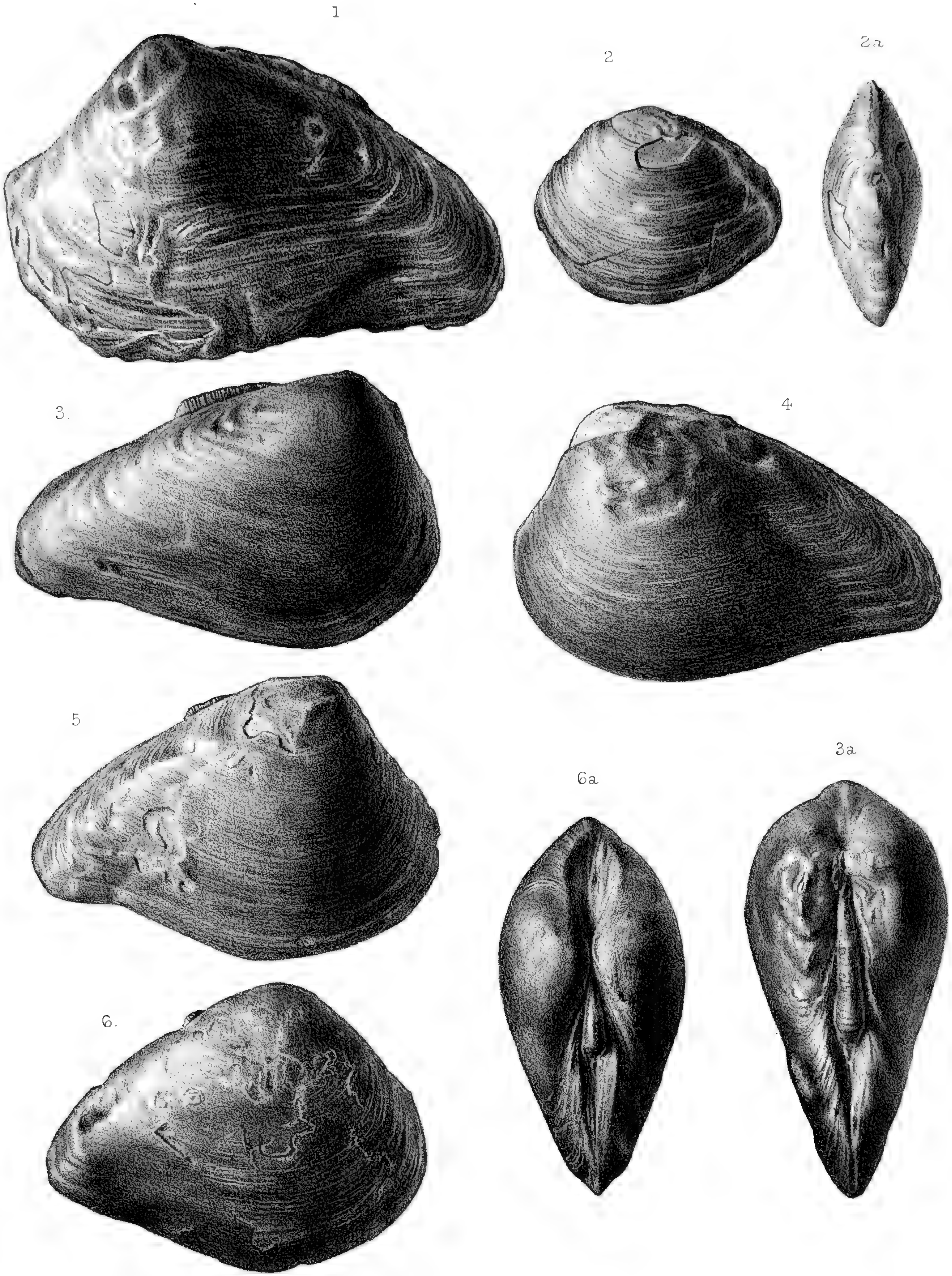
Fig. 4.—*Carbonicola robusta.* Dalmellington, Upper Coal-measures. Dr. John Young's Collection. (Page 45.)

Fig. 5.—*Carbonicola robusta.* Dalmellington, Upper Coal-measures. Dr. John Young's Collection. (Page 45.)

Fig. 6.—*Carbonicola robusta.* Upper Coal-measures, Dalmellington. A less transverse form from Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 6 *a.*—The same, showing the external view of the hinge and ligament. (Page 45.)

PLATE I



A. H. Searle del. et lith.

Mintern Bros. imp.

PLATE II.

Fig. 1.—*Carbonicola robusta.* Transverse form from Limerigg Slamannan Collection of Mr. Smith of Kilwinning, Ayrshire. (Page 45.)

Fig. 1 *a.*—*Carbonicola robusta.* The same shell, showing interior and hinge of the right valve. *a.* The edentulous anterior portion of the hinge-plate. *b.* Cardinal tooth somewhat bevelled at the expense of its lower border. *c.* Concavity for cardinal tooth of the left valve. *d.* Plain toothless surface of the posterior part of the hinge-plate. The unsinuated pallial sinus and posterior adductor scar, are also shown. (Page 45.)

Fig. 2.—*Carbonicola robusta.* Small form from Shotts. Same Collection. (Page 45.)

Fig. 3.—*Carbonicola robusta.* A more rotund form from Upper Coal-measures, Airdrie. Dr. John Young's Collection. (Page 45.)

Fig. 4.—*Carbonicola robusta.* Dalmellington. Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 5.—*Carbonicola robusta.* Quadrate form from Dalmellington. Dr. Hunter's Braidwood Collection. (Page 45.)

Fig. 5 *a.*—The same, showing cast of the interior and hinge-line. (Page 45.)

Fig. 6.—*Carbonicola robusta.* Young form. Mr. Beveridge's Collection. (Page 45.)

Fig. 7.—*Carbonicola rugosa.* From Cant Clough, Burnley. Mr. George Wild's Collection. (Page 49.)

Fig. 8.—*Carbonicola rugosa.* From Hebden Bridge. Collection of the Geological Survey, Jermyn Street. (Page 49.)

Fig. 8 *a.*—The same, showing external ligament and hinge-line.

Fig. 9.—*Carbonicola robusta.* Hinge-plate of specimen from the Holly Lane Seam (?), Hanley and Bucknall Colliery, North Staffordshire. My Collection. (Page 45.)

Figs. 10 and 11.—*Carbonicola robusta.* From the Shale above Stinking Coal, Froghall. My Collection. (Page 45.)

PLATE II.

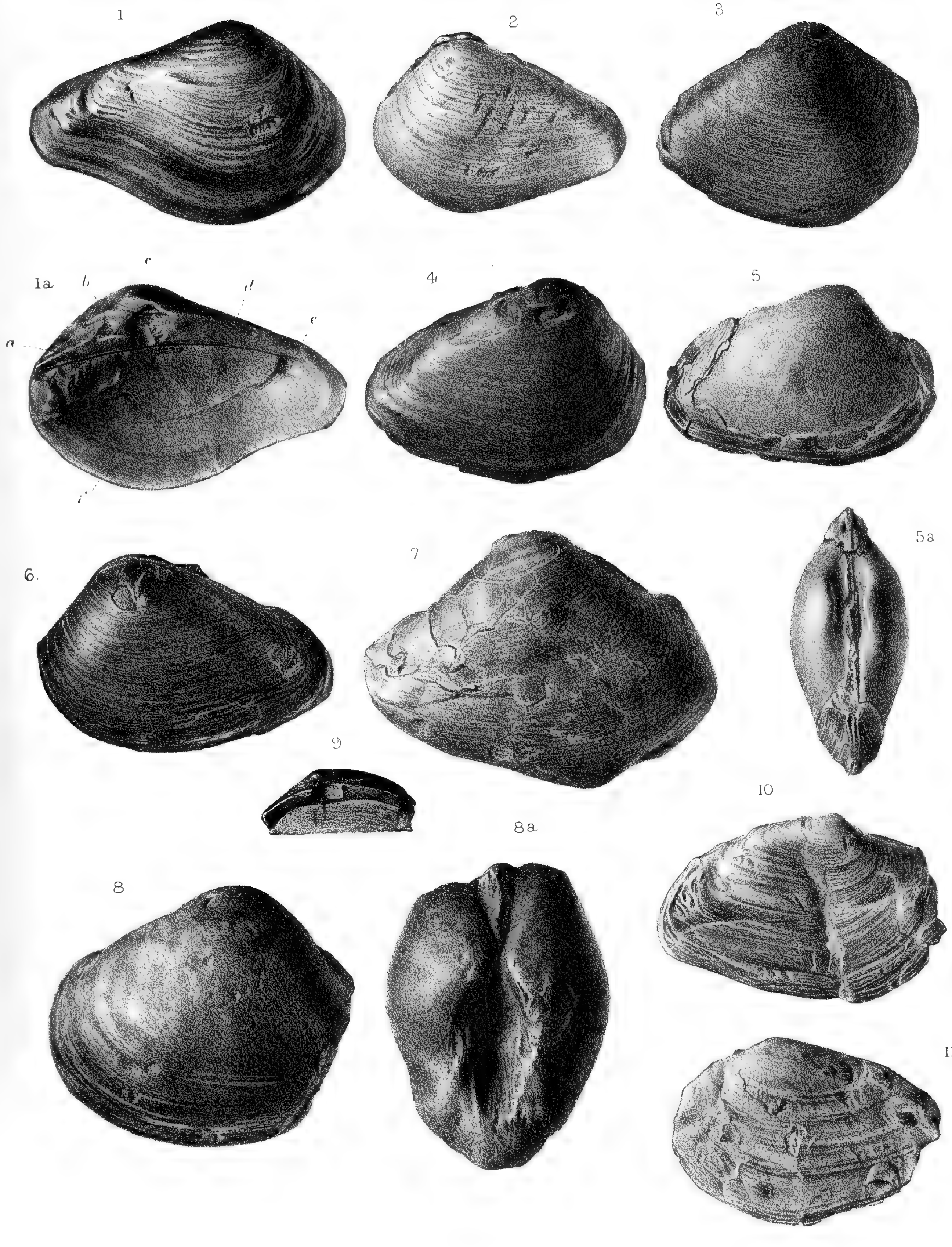


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PLATE III.

Fig. 1.—*Carbonicola acuta.* The original specimen, figured in vol. i, pl. xxxiii, fig. 6, in Sowerby's 'Mineral Conchology.' In the Sowerby Collection, Nat. Hist. Museum, South Kensington. (Page 50.)

Fig. 2.—*Carbonicola acuta?* Ditto, pl. xxxiii, fig. 5; but it is a question whether this shell should not rather be referred to *C. subconstricta.* (Page 53.)

Fig. 3.—*Carbonicola acuta?* From the original specimen figured, vol. i, pl. xxxiii, fig. 7, in Sowerby's 'Mineral Conchology.' In the Sowerby Collection of the Nat. Hist. Museum, South Kensington. (Page 54.)

Figs. 4—12.—*Carbonicola acuta.* A series from the roof of the Cockshead Coal Seam, Adderley Green, North Staffordshire, to show the variation in form and the gradual passage into *C. acuta*, var. *rhomboidalis.* My Collection. (Page 50.)

Figs. 5 *a* and 11 *a.*—*Carbonicola acuta.* Figs. 5 and 11 viewed from above, showing the lunule, the external ligament, and the bevelled edges of the hinge-plates posteriorly. (Page 50.)

Figs. 13—21.—*Carbonicola acuta*, var. *rhomboidalis.* From the roof of the Cockshead Coal, Adderley Green, North Staffordshire, all showing erosion of the umbones, an obliquity in the lines of growth to the long axis of the shell, and a marked broad, shallow, oblique constriction on the surface of the valve. My Collection. (Page 55.)

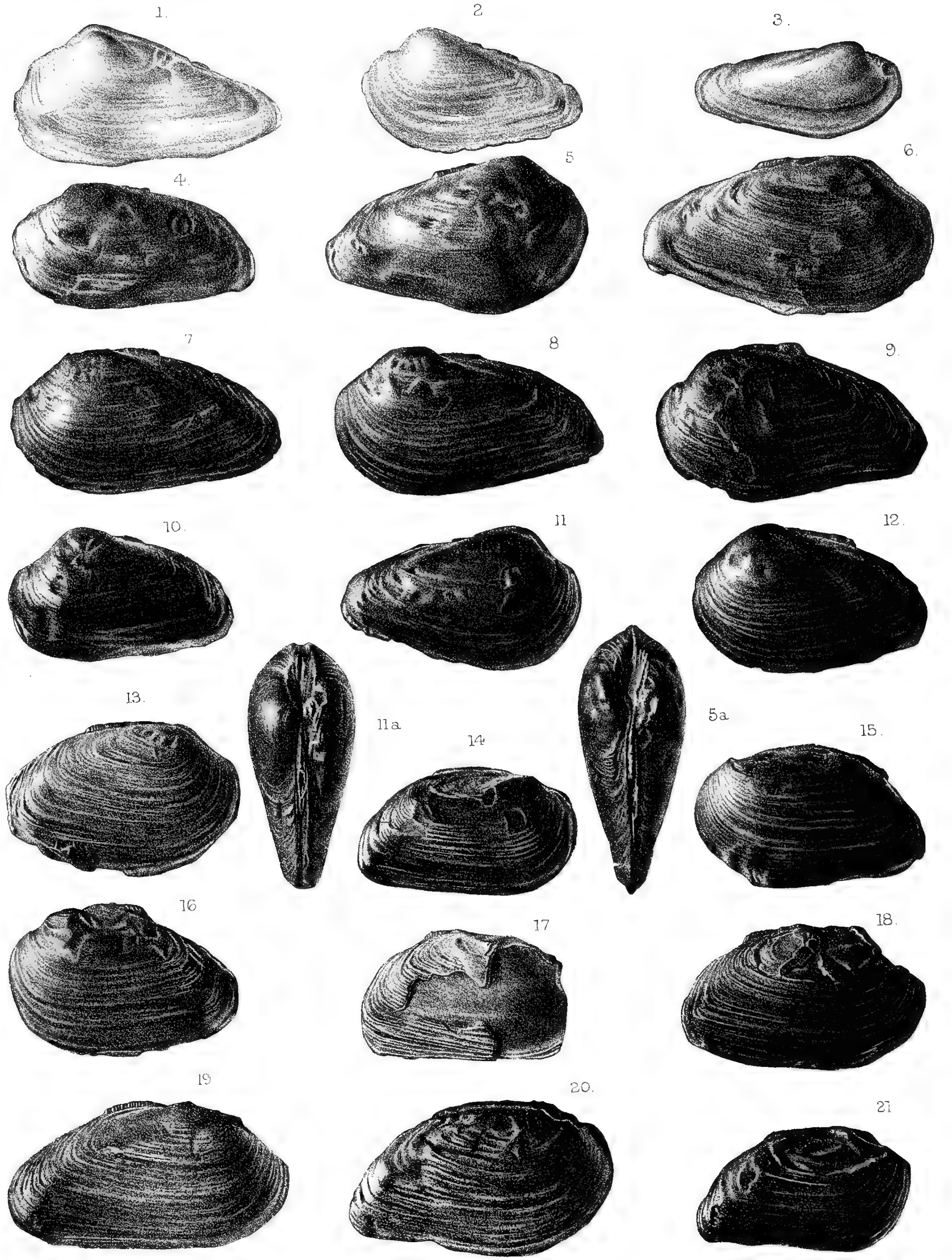

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PLATE IV.

Figs. 1—7.—*Carbonicola acuta*, var. *rhomboidalis*. Showing the passage from a truncate and obtuse posterior end to a beaked and sinuated form. From the roof of the Cockshead Seam, Adderley Green, North Staffordshire. My Collection. (Page 55.)

Figs. 8—12.—*Carbonicola acuta*. To show the eroded umbones. Figs. 8 and 9 are different views of the same specimen. From the roof of the Cockshead Seam, Adderley Green, North Staffordshire. My Collection. (Page 50.)

Figs. 13—15.—*Carbonicola acuta*. A smaller form from the Nether Pit, Derbyshire. My Collection. (Page 50.)

Fig. 16.—*Carbonicola acuta*. A form with an almost obsolete anterior end, ? from the Upper Coal-measures of Ayrshire. In the Collection of Mr. Smith of Kilwinning. (Page 50.)

Fig. 17.—*Carbonicola acuta*. A compressed example from the Coal-measures of Coalbrookdale. In the Collection of Professor Prestwich. (Page 50.)

Fig. 18.—*Carbonicola ovalis*. The original specimen figured by Sowerby in Prestwich's "Geology of Coalbrookdale," 'Trans. Geol. Soc.,' Ser. 2, vol. v, pl. xxxix, fig. 13. From the Pennystone beds? Coalbrookdale. In the Collection of Professor Prestwich. (Page 56.)

Fig. 19.—*Carbonicola ovalis*. A cast of both valves from the Coal-measures of Coalbrookdale. In the Geological Collection of the Nottingham Museum. (Page 56.)

Fig. 20.—*Carbonicola ovalis*. From the Upper Coal-measures of Lanarkshire. From the Collection of Mr. J. Nielson, of Glasgow. (Page 56.)

Fig. 21.—*Carbonicola ovalis*. From the same locality and Collection. A form connecting *C. acuta* with *C. ovalis*. (Page 56.)

Fig. 22.—*Carbonicola ovalis*. From Butterley, Leicestershire. In the Geological Collection of the Nottingham Museum. (Page 56.)

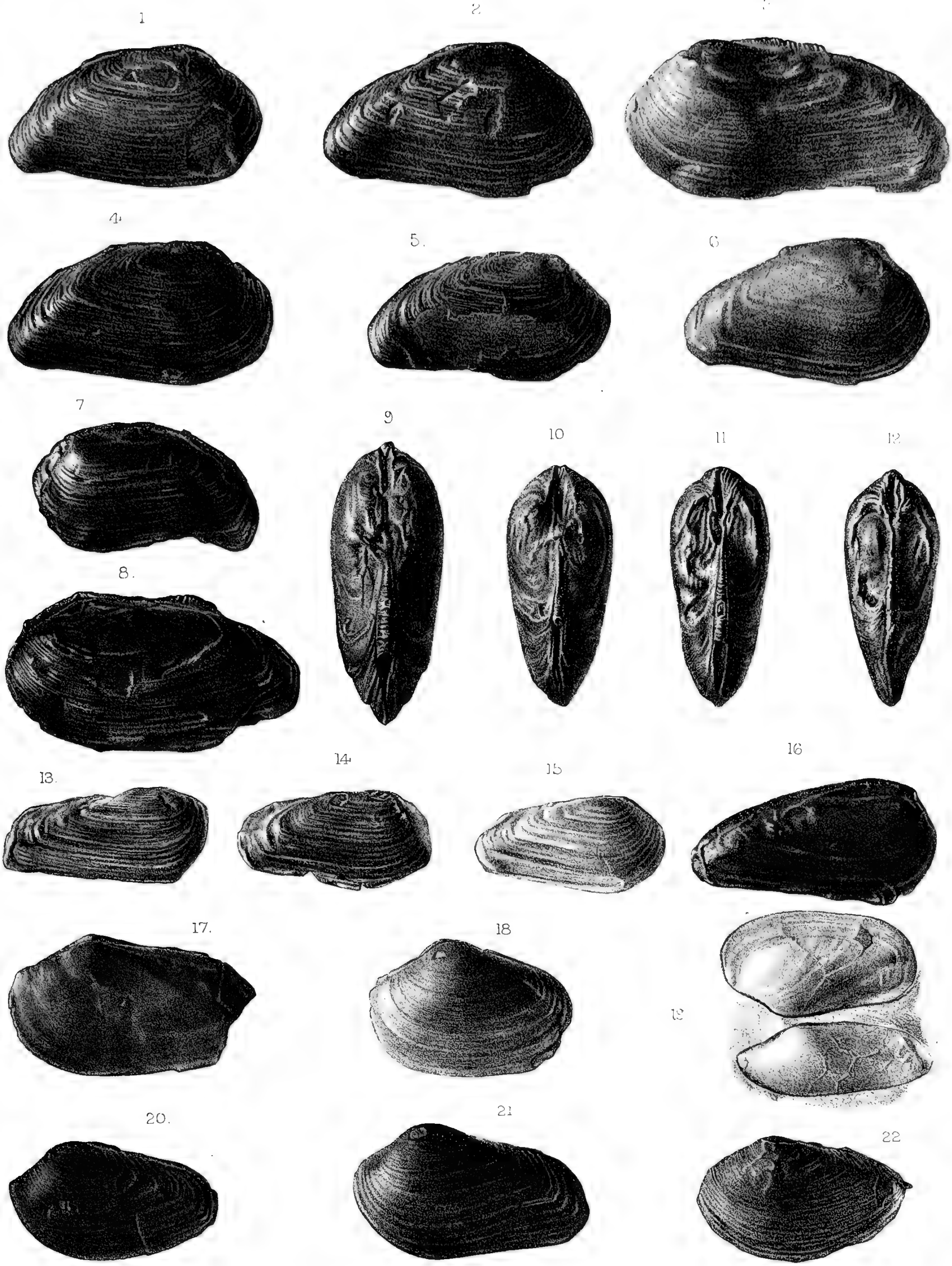

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PLATE V.

Fig. 1.—*Carbonicola acuta* (form α), showing the opposing hinge-plates of opposite valves from the Bowling Alley roof, Ivy House Colliery, Bucknall. This I regard as the normal form. My Collection. (Page 51.)

Fig. 2.—*Carbonicola aquilina*, showing the opposite hinge-plates of opposite valves. From the same locality as above. My Collection. (Page 69.)

Fig. 3.—*Carbonicola acuta* (form α). Left valve, showing hinge. Cockshead Rock, Hulme Colliery. My Collection. (Page 51.)

Figs. 5—11, 13, 15, 16.—*Carbonicola acuta* (form α). A series of valves from the Cockshead Rock, Hulme Colliery, Adderley Green, showing minute variations in details in the hinge. My Collection. (Page 51.)

Figs. 4 and 12. *Carbonicola acuta* (form α), showing the hinge, from the Ten-foot Coal, Bucknall. My Collection. (Page 51.)

Fig 14.—*Carbonicola acuta* (form α). View in profile of a section of the valve through the umbones. Same locality. My Collection. (Page 51.)

Figs. 17—34.—*Carbonicola acuta* (form β). A series showing the bevelling of the lower edge of the hinge-plate with occasional facets, and a transverse prolongation of the cardinal tooth, all with the exception of Fig. 32 from the same locality, this one coming from Hanley; and Fig. 22, which is from the roof of the Ten-foot, Bucknall. My Collection. (Page 52.)

Figs. 35—37.—*Carbonicola acuta*. A series showing the elongated cardinal tooth becoming bifid in the right valve. Same locality. Type γ. My Collection. (Page 52.)

Fig. 38.—*Carbonicola ovalis*. Left valve, showing a central cardinal tooth, with a pit anterior and posterior to it for the reception of the bifid teeth of the right valve. There is a faint indication of a posterior lateral tooth, also some pearly nodules. Same locality. My Collection. (Page 56.)

Fig. 39.—*Carbonicola acuta*. Right valve, showing a trifid cardinal tooth. Same locality. My Collection. (Page 50.)

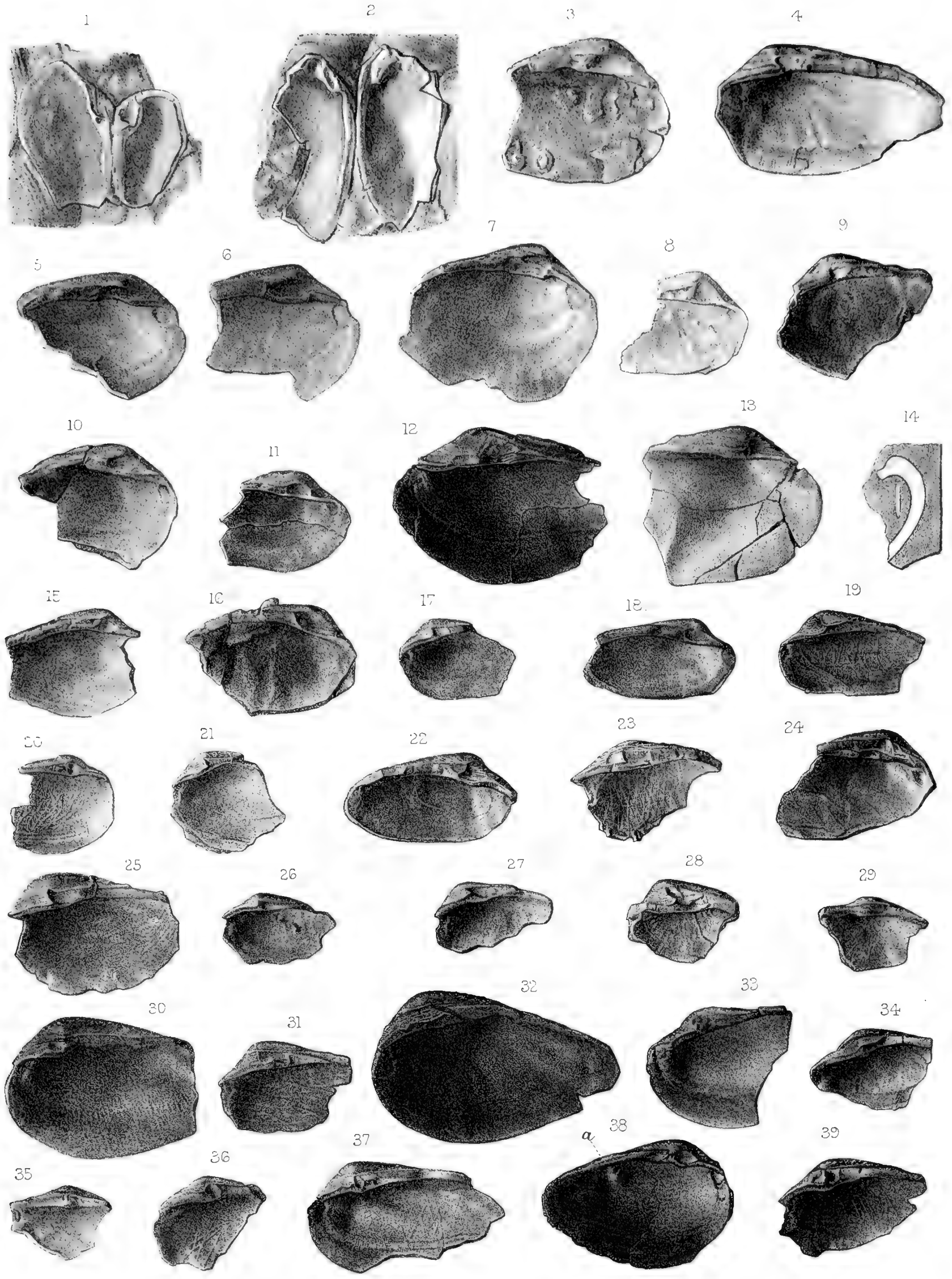

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PLATE VI.

Fig. 1.—*Carbonicola acuta.* Left valve, showing single median cardinal tooth. From the Cockshead Rock, Adderley Green. My Collection. (Page 50.)

Fig. 2.—*Carbonicola acuta.* Right valve, showing a slight indication of a posterior lateral tooth. Same locality. My Collection. (Page 50.)

Fig. 3—42.—*Carbonicola acuta.* A series from the same locality, exhibiting several variations in detail and form of the hinge apparatus. (Page 50.)

Fig. 43.—*Carbonicola acuta.* A left valve from the Collection of the Woodwardian Museum, Cambridge, from Bradford, Yorkshire, showing the absence of a posterior lateral tooth. (Page 50.)

Fig. 44.—*Carbonicola subconstricta.* A right valve from the same Collection and locality, showing a posteriorly diverging cardinal tooth with a corresponding pit posterior to it to receive the cardinal tooth of the opposite valve, and the absence of a lateral tooth. (Page 59.)

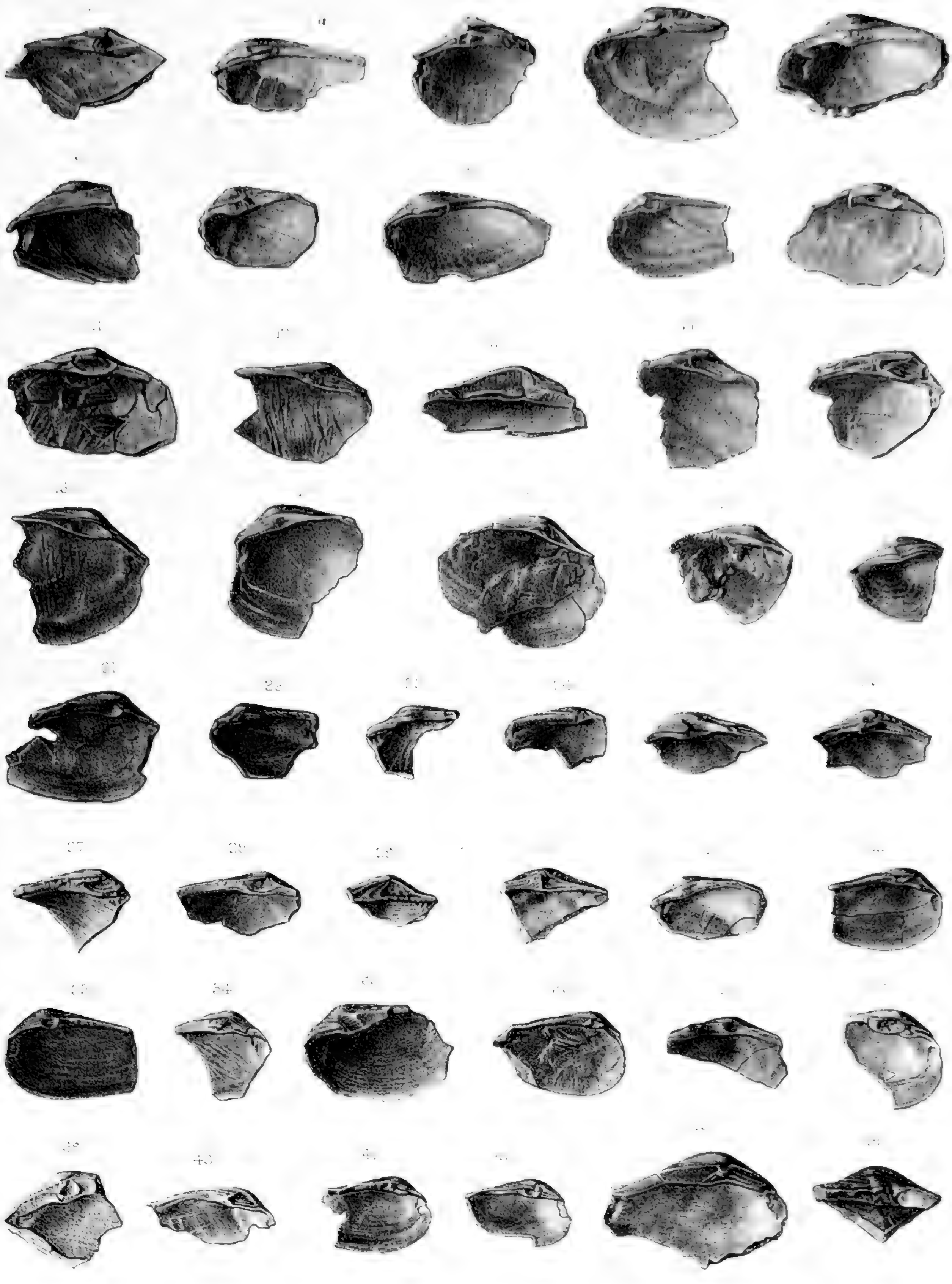

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PLATE VII.

Fig. 1.—*Carbonicola Polmontensis.* The cast of a full-grown example from Omoa, U. C. M. Scotland. Collection of Mr. James Nielson. (Page 58.)

Fig. 2.—*Carbonicola Polmontensis.* Cast showing the pallial line and the adductor muscle scars, from Kirkwood, U. C. M., Scotland. Same Collection. (Page 58.)

Fig. 3.—*Carbonicola Polmontensis.* A cast from Springhill Colliery, Kilmarnock. Collection of Mr. Beveridge. (Page 58.)

Fig. 3 *a*.—The same specimen viewed from above. (Page 58.)

Fig. 4.—*Carbonicola Polmontensis.* A cast from the Ell coal, Kilmarnock. Collection of Mr. Smith. (Page 58.)

Fig. 5.—*Carbonicola subconstricta.* The original of the figure in Sowerby's 'Min. Conch.,' vol. i, pl. xxxiii, fig. 1. In the Sowerby Collection, Nat. Hist. Mus., South Kensington. (Page 59.)

Fig. 6.—*Carbonicola subconstricta.* The original of the figure in Sowerby's 'Min. Conch.,' vol. i, pl. xxxiii, fig. 2. In the same Collection. (Page 59.)

Fig. 7.—*Carbonicola subconstricta.* The original of the figure in Sowerby's 'Min. Conch.,' vol. i, pl. xxxiii, fig. 3. In the same Collection. (Page 59.)

Figs. 8—10.—*Carbonicola subconstricta.* A series from Lowmoor, Bradford, Yorkshire, in the Collection of the Woodwardian Museum, Cambridge. (Page 59.)

Figs. 11 and 15.—*Carbonicola subconstricta.* Casts of large forms, showing pallial line and adductor scars from above the thin bed, Burnley. Collection of Mr. George Wild. (Page 59.)

Figs. 12 and 14.—*Carbonicola subconstricta.* A series from Lowmoor, Bradford, Yorkshire. My Collection. (Page 59.)

Fig. 14 *a*.—A view of fig. 14 seen from above. (Page 59.)

Fig. 16.—*Carbonicola obtusa.* From the Lower Coal-measures of North Staffordshire, Whitfield Colliery. The shale has been worked away from these valves since the drawing was made, and the hinge-plates are to be seen on Pl. XI, fig. 1. My Collection. (Page 61.)

Figs. 17 and 18.—*Carbonicola obtusa.* Full-sized examples from the Cockshead Rock, Hulme Colliery, Adderley Green. (Page 61.)

Fig. 18 *a*.—Fig. 18 seen from above. My Collection. (Page 61.)

Fig. 19.—*Carbonicola obtusa.* A specimen from the M. C. M. of Ashton-under-Lyme, in the Collection of the Woodwardian Museum, Cambridge. (Page 61.)

Fig. 19 *a*.—*Carbonicola obtusa.* The same specimen, viewed from above, showing ? eroded umbones and the wide and excavated lunule. (Page 61.)

Figs. 20—23.—*Carbonicola obtusa.* A series of young forms from a disused pit on the same horizon as the Hulme Colliery, Dividy Lane. My Collection. (Page 61.)

Figs. 24—29.—*Carbonicola nucularis.* A series from the roof of the Hard Mine Coal of Adderley Green and Bucknall, showing variations in shape; all casts. My Collection. (Page 63.)

Figs. 26 *a* and 29 *a*.—Two of the specimens showing the casts of the umbones and hinge-line. (Page 63.)

Figs. 30 and 31.—*Carbonicola nucularis.* Two testiferous specimens from beds of the same horizon, Talk-o'-th'-Hill. My Collection. (Page 63.)

Figs. 32—42.—*Carbonicola nucularis.* A further series from the roof of the Hard Mine Coal, North Staffordshire. My Collection. (Page 63.) The number 39 on the left-hand side should be 36.

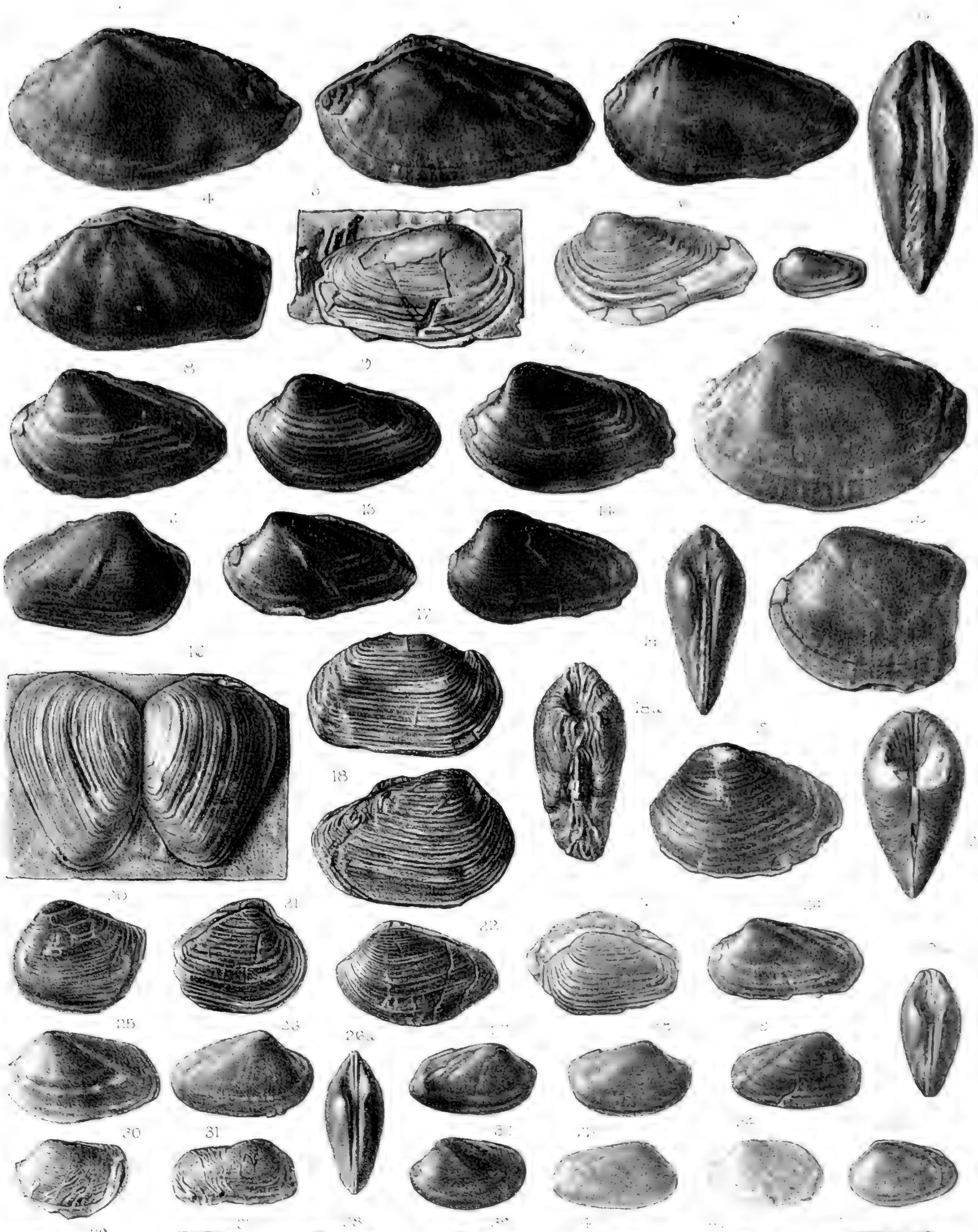

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PLATE VIII.

Fig. 1.—*Carbonicola gibbosa.* From the roof of the Moss Coal, Fenton, showing anterior end view and deep lunule. Collection of Mr. John Ward, F.G.S. (Page 65.)

Fig. 1 *a.*—The same shell. Lateral view.

Fig. 1 *b.*—The same shell, showing the umbones, external ligament, and upper surface.

Fig. 2.—*Carbonicola gibbosa.* Another example from the same bed. Collection of Mr. J. Ward, F.G.S. (Page 65.)

Figs. 3—7.—*Carbonicola subrotunda.* A series from the Lower Coal-measures of North Staffordshire, exact horizon not known, but some distance above the Hard Mine Seam. The bed was passed through in sinking the Adderley Green Colliery. My Collection. (Page 65.)

Figs. 4 *a* and 5 *a.*—The upper surfaces, umbones, lunule, and external ligaments of figs. 4 and 5. (Page 65.)

Fig. 8.—*Carbonicola turgida.* A typical specimen from Stubb's Mine, Bardsley. My Collection. (Page 66.)

Fig. 8 *a.*—The same specimen, seen from above. (Page 66.)

Fig. 9.—*Carbonicola turgida.*—Showing the hinge-plate and interior of a right valve. Stanley Main Seam, Wakefield. My Collection. (Page 66.)

Figs. 10—12 *a.*—*Carbonicola turgida.* A series from the horizon of Stubb's Mine, Bardsley. Presented to me by Mr. George Wild. My Collection. (Page 66.)

Fig. 13.—*Carbonicola turgida.* Coalbrookdale. My Collection. (Page 66.)

Fig. 14.—*Carbonicola turgida.* A cast from the Splint Coal, Wishaw, in the Braidwood Collection of Dr. Hunter. (Page 66.)

Fig. 15.—*Carbonicola turgida.* A cast from the Ell Coal, Cambushlang. From the same Collection. (Page 66.)

Fig. 16.—*Carbonicola turgida.*—A cast showing muscle-scars from Shettleston, in the Collection of Dr. John Young. (Page 66.)

Fig. 16 *a.*—The same cast, viewed from above. (Page 66.)

Fig. 17.—*Carbonicola turgida.* A young and shortened form from the Collection of Dr. John Young. (Page 66.)

Fig. 17 *a.*—The same shell viewed from above.

Fig. 18.—*Carbonicola turgida.* Coalbrookdale. My Collection. (Page 66.)

Fig. 18 *a.*—The same shell viewed from the front, showing the deep heart-shaped lunule.

Fig. 18 *b.*—The same shell seen from above.

Fig. 19.—*Carbonicola turgida.* A large example from the North Staffordshire Coal-field. Horizon not known. My Collection. (Page 66.)

Fig. 20.—*Carbonicola turgida.* Coalbrookdale, Madeley Court. A pretty little shell, whose posterior end has not developed. In the Collection of the Woodwardian Museum, Cambridge. (Page 66.)

Fig. 21—25.—*Carbonicola turgida.* A series of young forms from the roof of the Moss-coal, Lane End Colliery, Fenton. My Collection. (Page 66.)

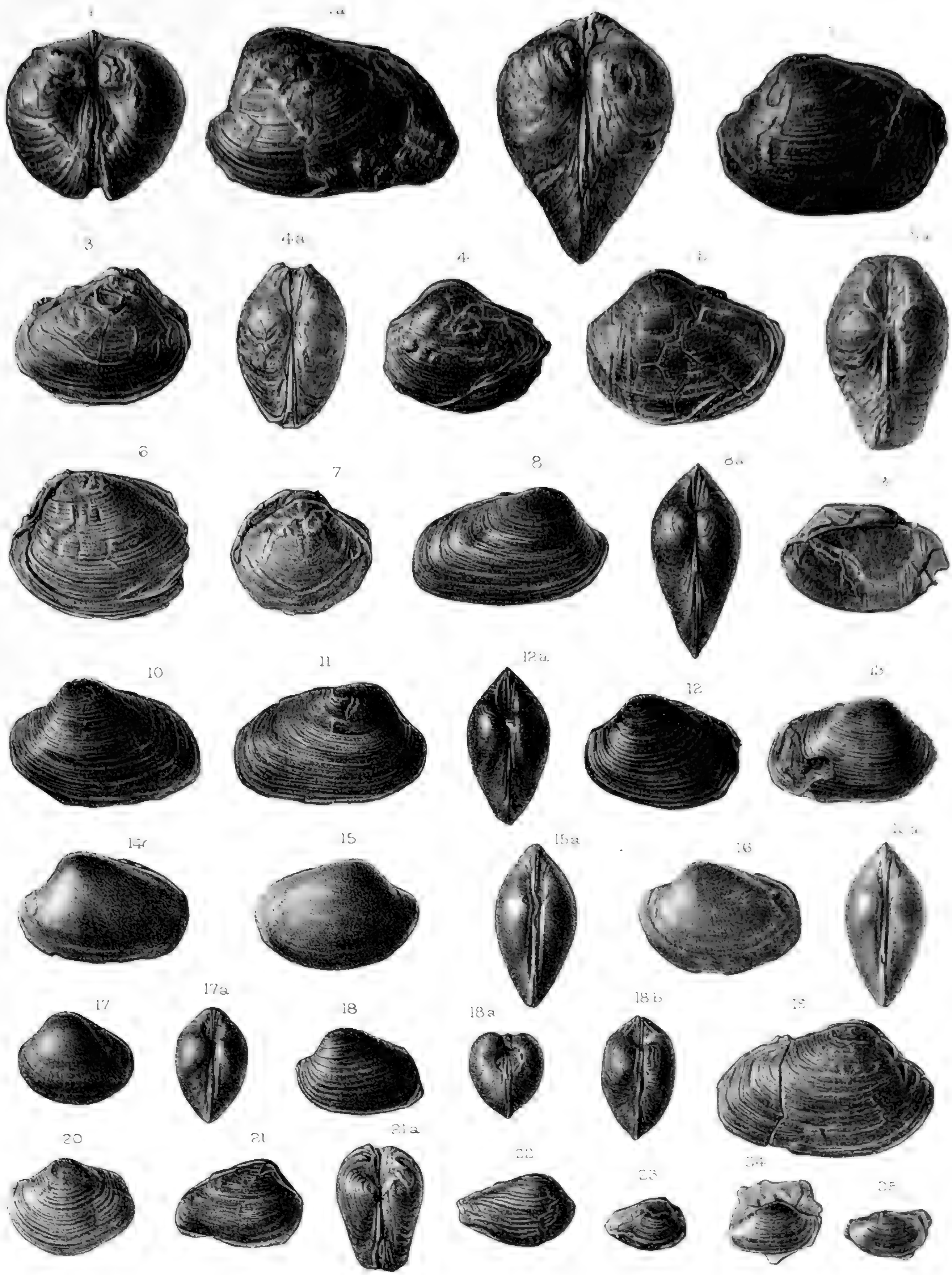

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PLATE IX.

Figs. 1 and 2.—*Carbonicola aquilina.* From the locality of the original specimen, Blue Flats, Coalbrookdale. My Collection. (Page 69.)

Figs. 3 and 4.—*Carbonicola aquilina.* From the Brooch Coal, Dudley. Presented to me by Mr. Wm. Madeley. My Collection. (Page 69.)

Fig. 5.—*Carbonicola aquilina.* From old workings at Whitley, Northumberland, the original locality of Professor King's *Anthracosia Beaniana*, showing the anterior two-thirds of the hinge-plate. My Collection. (Page 69.)

Figs. 6 and 7.—*Carbonicola aquilina.* In the Manchester Museum Collection, Owens College. (Page 69.)

Fig. 8.—*Carbonicola aquilina.* Showing typical anterior end from the Grains Ironstone, Dudley. Presented to me by Mr. Wm. Madeley. My Collection. (Page 69.)

Fig. 9. *Carbonicola aquilina.* A fine interior from the roof of the Bowling Alley Seam. Ivy House Colliery, Hanley. It has evidently been fractured, but repaired during life. My Collection. (Page 69.)

Figs. 10, 12, and 13.—*Carbonicola aquilina.* From the Coal-measures, Whitley, showing portions of the hinge-plate. Fig. 12 has the right valve crushed, but the hinge-plate is in shadow at (*a*). My Collection. (Page 69.)

Fig. 11.—*Carbonicola nucularis.* Whitley. Showing hinge-plate. My Collection. (Page 63.)

Fig. 14.—*Carbonicola aquilina.* Horizon of the Thick Coal, Tipton, South Staffordshire, showing the hinge-plate of the left valve, owing to the slipping of one valve over the other. Presented to me by Mr. Waring. My Collection. (Page 69.)

Figs. 15—24.—*Carbonicola aquilina.* Whitley. A series to show the variation in form and in the surface markings from one locality. My Collection. (Page 69.)

Fig. 25.—*Carbonicola aquilina.* From the Brooch Coal, Dudley. My Collection. (Page 69.)

Figs. 26—30.—*Carbonicola aquilina.* Clough Hall Collieries, North Staffordshire. Pyritised specimens in black shale about the horizon of the Banbury seams. Figs. 29 and 30 show a strongly wrinkled periostracum. My Collection. (Page 69.)

Figs. 31—36.—*Carbonicola aquilina.* A series from one horizon in the Wigan Coal-field showing the typical form of the *Unio lateralis* of Brown. Figs. 35 and 36 are much elongated transversely. (Page 69.)

Fig. 37.—*Carbonicola aquilina.* From roof of the Hard Mine Coal. Hulme Colliery, Adderley Green. My Collection. (Page 69.)

PLATE IV

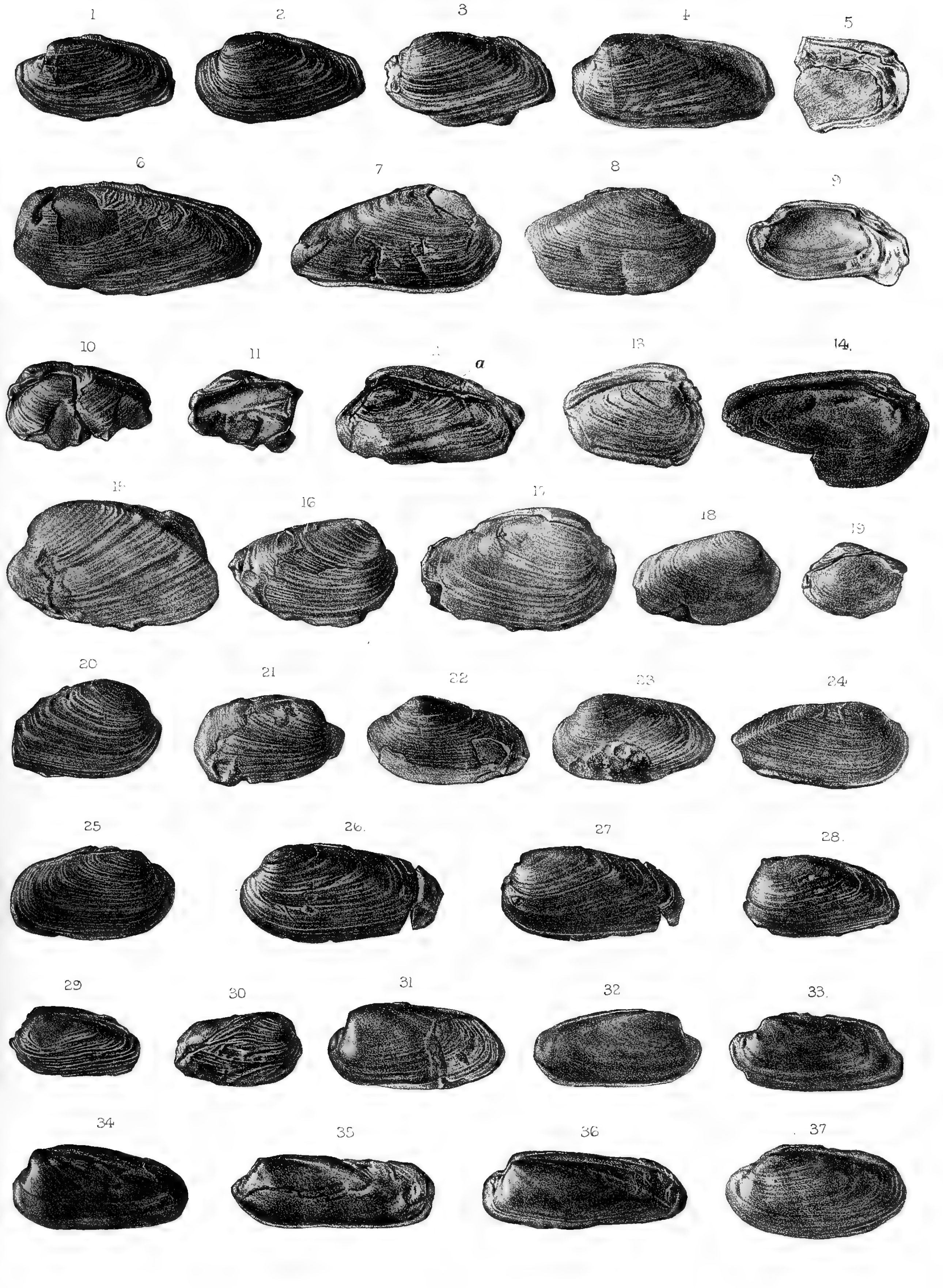

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PLATE X.

Fig. 1.—*Carbonicola aquilina.* A large form from the roof of the Moss Coal, Longton. Collection of Mr. John Ward, F.G.S. (Page 69.)

Figs. 2—6.—*Carbonicola aquilina.* A series from the roof of the Moss (or Eastling) Coal. Lane End Colliery, Fenton. My Collection. (Page 69.)

Figs. 7—17.—*Carbonicola aquilina.* A series to show variability in form, from the roof of the Hard Mine Coal, Adderley Green. My Collection. (Page 69.)

Fig. 18.—*Carbonicola aquilina.* From a plaster-of-Paris cast. The original passed through my hands in transit from Mr. George Wild to Professor Amalizky, of Warsaw. From the Stubb's Mine, Bardsley. Cast in my Collection. (Page 69.)

Figs. 19—42.—*Carbonicola aquilina.* A series of casts from the roof of the Hard Mine Coal, Adderley Green, to show stages of growth and the variation in form of even young examples, the smallest forms resembling the *Unio phaseolus* of Sowerby. My Collection. (Page 69.)

Figs. 19 *a*, 20 *a*, 21 *a*.—Figs. 19, 20, and 21 viewed from above, showing casts of the hinge-line and umbones. The anterior adductor scars and those from the accessory pedal muscles above and posterior to them are well seen, also the sinuous line indicating the position of the hinge-teeth. (Page 69.)

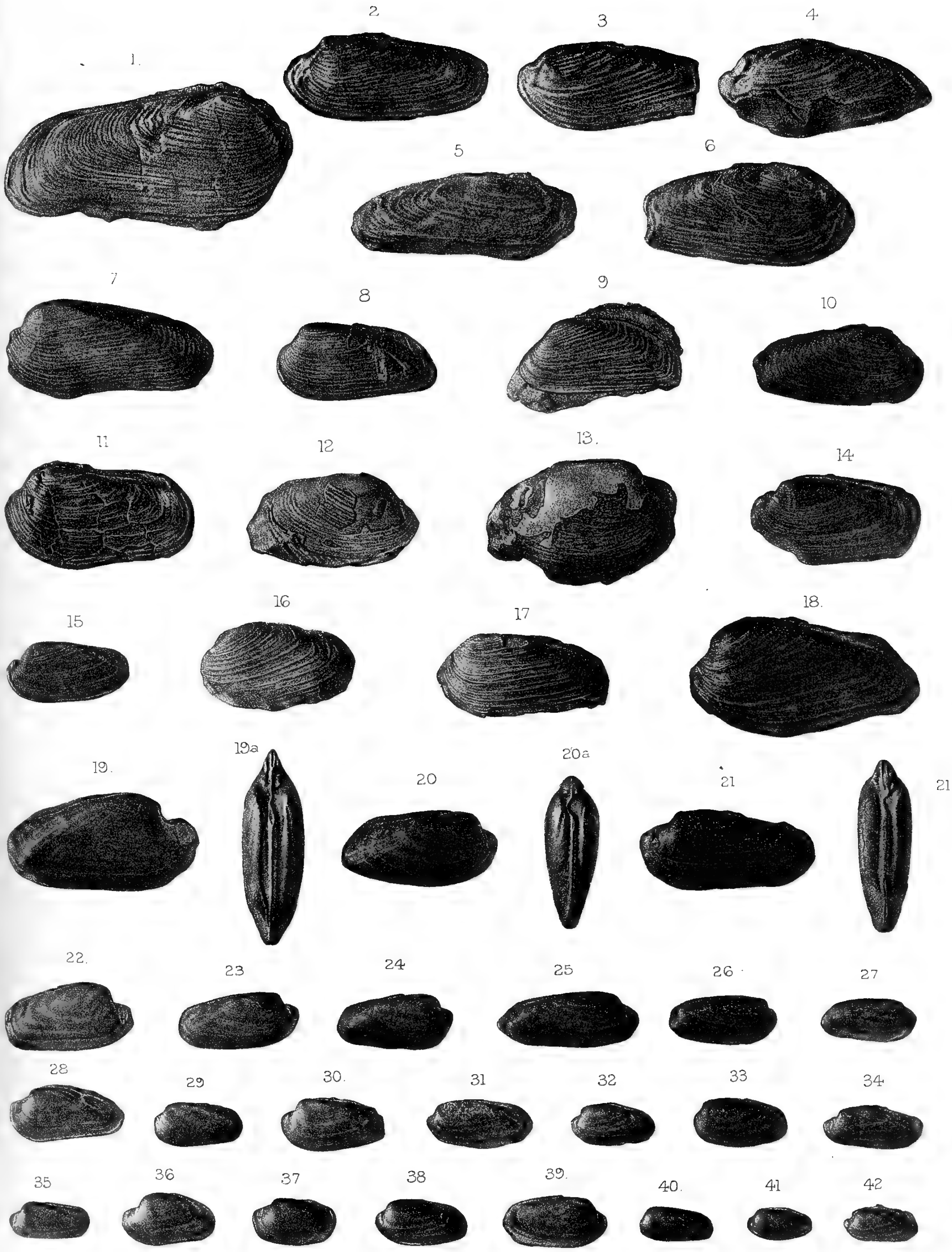

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PLATE XI.

Fig. 1.—*Carbonicola obtusa.* The hinge-plates of the shell figured on Pl. VII, fig. 16, showing a striated pit in the right valve posterior, and in the left anterior, to the cardinal tooth. (Page 61.)

Fig. 2.—*Carbonicola obtusa.* Cockshead Rock, Hulme Colliery, Adderley Green, North Staffordshire. Transverse section, showing a cavity between the hinge-plates, in which possibly was lodged an internal ligament or cartilage. The section is just posterior to the highest point of the umbones. My Collection. (Page 43.)

Figs. 3 and 4.—*Carbonicola angulata.* Two pyritised examples from the Low Bottom Bed. Fulledge, Burnley. In the Collection of Mr. George Wild. (Page 75.)

Fig. 5.—*Carbonicola angulata.* From same locality, a larger specimen. In the Collection of Mr. John Ward, F.G.S., of Longton. (Page 75.)

Figs. 6 and 7.—*Carbonicola similis.* Two typical specimens from the Brooch Coal Series, Dudley. My Collection. (Page 76.)

Fig. 7 *a.*—*Carbonicola similis.* Fig. 7 viewed from above, showing the hollow character of the dorsal slope.

Fig. 8.—*Carbonicola similis.* Cast showing muscle-scars and pallial line. Springhill Colliery, Ayrshire. In the Collection of Mr. Beveridge. (Page 76.)

Fig. 8 *a.*—The same viewed from above, showing the accessory pedal scars.

Figs. 9—13.—*Carbonicola similis.* A series from the Brooch Coal-beds, Dudley, showing the change in shape of the posterior end by age. Presented to me by Mr. Wm. Madeley. My Collection.

Figs. 10 *a*, 11 *a.*—*Carbonicola similis.* Figs. 10 and 11 viewed from above, showing external ligament and general shape of the superior surface. (Page 76.)

Figs. 14, 14 *a.*—*Carbonicola nucularis.* Two views of a very testiferous pyritised specimen with much-wrinkled periostracum from the horizon of the Banbury, ? Hard Mine, Talk-o'-th'-Hill, North Staffordshire. My Collection. (Page 63.)

Fig. 15.—*Carbonicola similis.* Brooch Coal Series, Dudley. To show the hinge-plate of the right valve. My Collection. (Page 76.)

Fig. 16, 16 *a.*—*Carbonicola nucularis.* Two views of a testiferous specimen from the spoil bank of a disused colliery at the west foot of Mow Cop, North Staffordshire, which from the fossil contents I believe to be about the horizon of the Hard Mine, showing much-wrinkled periostracum. My Collection. (Page 63.)

Figs. 17—23, 25—27. *Carbonicola similis.* A series from a thin bed above the Cockshead Rock, Hulme Colliery, Adderley Green, North Staffordshire, showing variations in shape often due to crushing. My Collection. (Page 76.)

Fig. 24.—*Carbonicola cuneiformis.* The roof of the Hard Mine Coal, Bucknall. My Collection. (Page 78.)

Fig. 24 *a.*—*Carbonicola cuneiformis*, viewed from above.

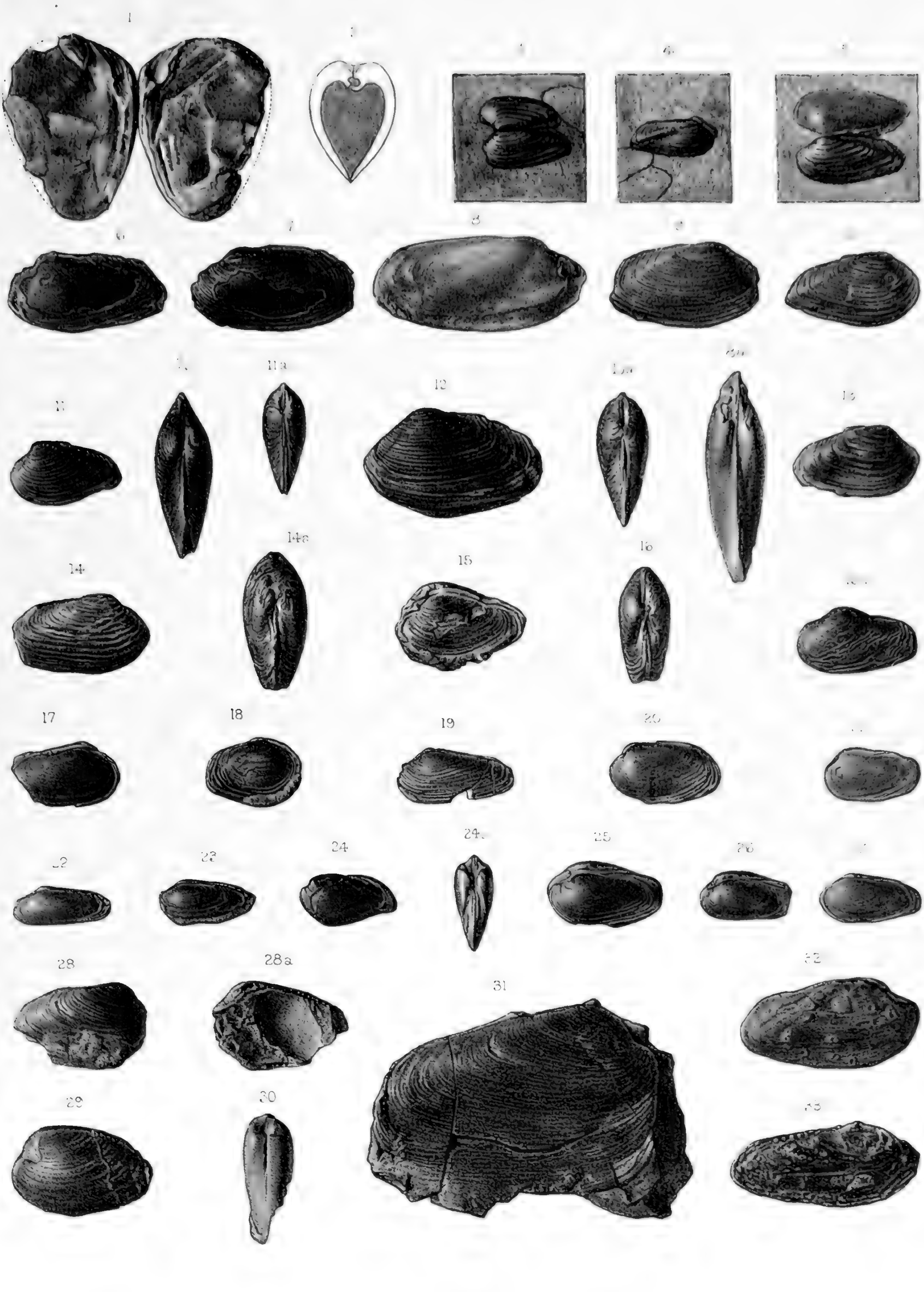
Figs. 28, 29.—*Carbonicola antiqua.* From the Calciferous Sandstone Series, Kilminning, Fife. My Collection. (Page 79.)

Fig. 28*a.*—*Carbonicola antiqua.* An imperfect view of the hinge-plate of fig. 28.

Fig. 30.—*Carbonicola antiqua.* This is not a cast, but the shell has been worn smooth by wave action. From the same bed. My Collection. (Page 79.)

Fig. 31.—*Carbonicola aquilina.* A very large and fine example from the roof of the Hard Mine Coal, Adderley Green Colliery, Longton. My Collection. (Page 69.)

Figs. 32 and 33.—*Carbonicola aquilina*, to show curious circular perforations. Collection of Mr. John Ward, F.G.S., Longton. (Page 74.)



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THE

PALÆONTOGRAPHICAL SOCIETY.

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VOLUME FOR 1894.

LONDON:

MDCCCXCIV.

A MONOGRAPH

ON THE

INFERIOR OOLITE AMMONITES

OF

THE BRITISH ISLANDS.

BY

S. S. BUCKMAN, F.G.S.,

HONORARY MEMBER OF THE YORKSHIRE PHILOSOPHICAL SOCIETY.

PART IX.

Pages 377—456; Plates XCIII—CIII.

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1894.

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Ventral area rather flattened, rounded, divided by a small, rounded, fairly-defined, presumably hollow carina. Inner margin fairly defined, steep, convex. Inclusion about one-third. Umbilicus rather flat and open. Whorl-section oblong. Suture-line simple, the superior lateral lobe symmetrical, the lateral lobules much abbreviated, equipoised, bipartite, the terminal lobule axial, isosceloid, and equicellate.[1]

A peculiar character in this species is the intervention of a short costate stage between two spinous stages—a feature not seen in any of the species hitherto described; but it is noticeable in some to be mentioned later. The same character, for instance, may be seen in *Sonn. reformata* (Pl. LXXXIX, figs. 6—8); but in that case it is associated with a complex suture-line (fig. 8). In the present species the suture-line is very simple, therefore it is hardly possible that there can be any close genetic affinity between these two forms.

The following species may be considered as more or less morphically equivalent to *Sonn. scalpta:*

Sonn. subcostata (Pl. LXXI, fig. 4), which has a smaller umbilicus, greater thickness, and connate sub-costæ.

Sonn. omphalica (Pl. LXXXIII, figs. 5—7) shows whorls (the outer one especially) more costate, a less spinous centre, and different whorl-section.

Sonn. euromphalica (Pl. LXXXV, figs. 1—3), more spinous centre, coarser costæ, less compressed whorls.

This cryptogenetic, and therefore most interesting form, *Sonn. scalpta*, is represented only by the one specimen depicted, of natural size, in Pl. LXXXVII —side and front views, figs. 1, 2; and suture-line, fig. 3. It is a beautiful example, showing all details of the test with the greatest clearness, both sides being almost equally well preserved. It owes its discovery to Mr. Darell Stephens, F.G.S., to whose collection it belonged. It came from the *Concavum*-zone of Bradford Abbas.

Sonninia abnormis, *S. Buckman.* Plate LXXXV, figs. 4—6.

Discoidal, compressed, hollow-carinate. Whorls ornamented at first with fairly large, regular spines, later with costæ and spinicostæ as about 1 to 2; then the spinicostæ decline to swollen ribs, separated by smaller ribs at intervals, about 2 to 1; nearly all the ribs slightly reflexed, reclining, very little ventrally-inclined, and bifurcate on the outer area. Ventral area not defined, rounded, divided by a small, well-defined hollow carina. Inner margin ill-defined, slightly indented for spines, convex, steep. Inclusion about one-third. Umbilicus

[1] The upper superior lateral lobe in fig. 3 (Pl. LXXXVII) is, owing to indifferent preservation, not quite so trustworthy as the lower one.

open, coarsely ornamented. Whorl-section elliptical. Suture-line simple, with short, wide-stemmed lobes; the superior lateral lobe slightly asymmetrical; the terminal lobule slightly intra-axial, inequicellate.

Several unusual features are found in this shell. In the costate stage most of the ribs are bifurcate;[1] the junction is certainly sometimes obscure, but the ribs on the outer lateral area are nearly twice as numerous as those on the inner lateral area, so that the outer lateral area appears regularly crenate. Further, many of the ribs, instead of being direct, are slightly reflexed as well as reclinate, as if to accommodate the insertion of these accessory and slightly smaller ribs. Lastly, there is a very marked simplicity of the suture-line.

None of the foregoing groups seem to accommodate this species; it appears, in fact, to be altogether isolated. Its ornamentation suggests *S. subspinosa* slightly, but this association is negatived by the simple suture-line. There is also a little resemblance to *Sonn. decorata;* but the present form is far more coarsely ornamented, with a much more elaborate spinous stage. From any of the forms with which its suture-line suggests connection—forms of the *submarginata*-, *costata*-, or *omphalica*-stocks—the peculiarities of the ornamentation, such as bifurcate, irregular, reflexed, reclinate ribs, indicate a wide distinction.

In general appearance this shell has a likeness to some species of *Hammatoceras;* but it has not the suture-line of that genus.[2] There is a very slight suggestion of *Ludwigia* in the reflexed ribbing, and in the simplicity of the suture-line; but the reflexed ribbing is not sufficiently pronounced, while the spinous centre and the hollow carina show that the association cannot be entertained.

The specimen figured is unique; it came from Bradford Abbas, presumably from the *Concavum*-zone. Side and front views are shown in figs. 4, 5, of Pl. LXXXV; and the suture-line in fig. 6.

[1] Bi- and tri-furcation of the spine-bearing rib in the spinous stage is not uncommon, but here furcation is seen when the spines have become obsolete.

[2] See "Descent of *Sonninia*, &c.," 'Quart. Journ. Geol. Soc.,' vol. xlv, p. 652.

SONNININÆ (*continued*).

Genus—SONNINIA (*continued*).

REVISION OF THE *Sonniniæ* OF THE *Concavum*-ZONE, AND DESCRIPTIONS OF NEW SPECIES.

It has become necessary to change the method adopted in grouping these species of *Sonninia.* The various investigations necessary for specific determination have revealed that extreme septal differences were hidden beneath great external similarity of form—a similarity which, standing alone, had been considered too great to admit of specific distinction in view of protests, ofttimes unreasoning, against new species. Want of opportunity for thorough investigation is frequently the cause of such protests; and, in the present case, a certain want of thoroughness, partly induced perhaps by the remembrance of such protests, led to mistakes as serious as the following of the opposite course would have done. Too many forms were grouped under one specific name; and it is the object of the following observations on a revised classification to correct the mistakes which have arisen from this cause.

It was, perhaps, a rash assumption that external similarity of form should be coupled with internal septal likeness. In the case of *Dumortieria* and *Grammoceras* a difference of septation accompanies a certain outward similarity; yet, in most of the species, there are slight external differences which the eye soon becomes expert enough to detect. Such is, again, the case between *Sonninia* and *Hammatoceras:* there a difference in the trend of the ribs accompanies a noticeable difference in septation. In both of these cases, then, peculiar features of outward ornament always excite the suspicion of septal differences: in the present instance there was nothing to do this. By chance, however, it was discovered that examples of *Sonninia*, externally similar in dimensions and ornament, and without any difference in the trend of the ribbing, possessed markedly different septa. Then it became necessary to examine with great care the septation of every specimen.[1] Had this been done in the first place, certain

[1] This proved to be an immense labour. First, the specimens of *Sonninia* from Bradford Abbas either do not show the septal margins because the test is present, or they show them very badly, because when the test is absent the surface is eroded. When the test is present it is necessary to remove it. When the core is hard and smooth, the test, if it be crystalline and not too securely attached to the core, may be removed by chipping with a small chisel (a fine-tempered bradawl or a strong carpet-needle ground to a chisel-edge about 1 mm. broad) held nearly at right angles to the specimen. If, however, the test be firmly adherent, it can be induced to leave only by repeated small blows with an

mistakes and alterations would have been avoided; but unfortunately it was not done. It can easily be understood why: a natural reluctance to injure good specimens by breaking away their test; an equally natural disinclination to

adze-edged hammer, acid being subsequently applied to remove roughness. If the core be soft and inclined to break away, the test can only be removed by filing or rasping, with subsequent use of acid. If the core be crystalline, acid should not be used; it tends, for some reason, to obliterate the septal margin.

When the septa can be seen the outline of the margin may be traced over with a pen holding Indian-ink—in the case of black fossils, white paint. For this work a lens will often be required. When the septa are very indistinct, wetting will show them more plainly, and they may then be followed by a coloured pencil. When marked the outline must be traced by means of transparent tracing-paper and a soft pencil: the quality of the tracing-paper is very important. The tracing is then placed over a sheet of tissue-paper which has been rubbed over with red chalk on its lower side. This is laid on a sheet of paper. With a blunt needle the tracing is followed. This gives an outline in red on the paper. This outline must be followed with a pencil, at the same time that such corrections are made as a careful comparison with every curve of the original on the fossil may indicate; because inequalities of surface cause the pencil to slip in the first tracing, and the marking off afterwards is often not exact. The result, however, should not be much amiss. The errors in my experience arise most frequently from incorrect marking in the first place, owing to the indistinctness of the septal edge: in fossils from calcareous strata this is a serious difficulty. In the subsequent work the errors are slight.

The above is the method I have used for some years, but lately I have introduced modifications from a hint by M. Nicklès.* The tracing is placed in a photographic printing frame, and on it is laid a sheet of ferro-prussiate paper. Exposed to the sun and then washed, this gives the curves of the septal margin in white outline. The white outline is followed by a pen holding Indian-ink, and carefully compared with the original for each curve and denticulation. When the ink is dry the blue colour of the paper may be removed by touching lightly with a brush full of *sodium carbonate*.

A further method I have also adopted from a hint given me by Mr. Charles Upton. The alternate chambers are painted red and white: it is a most tedious process, but is often useful when the septa are indistinct. When painted they can be photographed. One error—unless several plates of the same septal margin be taken from different positions—will be a certain foreshortening of the outer and inner parts, particularly of the outer part. Another, and in certain cases more serious error is partly optical and partly photographic. The eye does not allow the two colours to come into actual contact in the work, for if they do the white will be stained red. The consequence is that the part uncovered by white takes photographically, from our yellow or brown fossils, as if it were red—the stained white would do the same. The result is a certain subtraction from the white painted chamber and an addition to the red painted one. In consecutive septa with thin-stemmed lobes there arises a noticeable difference in the width of the stem.

In connection with the painting process it may be mentioned that it is an admirable method for displaying the septation on the specimens, and it is one which may be commended for public collections, as the different septa in various specimens can be compared at a glance. Further, it is very easy to trace off the septal outline from fossils so painted.

In regard to the photographic treatment of septa the reader may be referred to the pamphlet by Dr. Nicklès (*op. cit.*). Elaborate directions are given, and to ensure accuracy it is evident that the

* "Application de la Photographie au dessin des cloisons des Ammonites," 'Bull. de l'Assoc. des Elèves de l'École des Mines,' 1893.

undertake so laborious and apparently so wanton a task, of which the need was not understood,—these were the causes why it was not done. But, when the necessity was proved, the task was undertaken and carried to an end, though the author stood thereby self-convicted of error.

In connection with the following scheme for a classification of the *Sonniniæ* of the *Concavum*-zone, based upon the evidence of their various septa, it must be understood that, in certain cases, Ammonites have septa which are unlike on the two sides. Such cases may be classed as abnormalities, similar, though less in degree, to such abnormalities as Ammonites with two different sides, or as d'Orbigny's "Turrilites." In some cases these departures from bilateral symmetry may become normal, as in the true Turrilites; and then such a development, which might be called "a persistent abnormality," would become of value in the matter of classification. So far, in the *Sonniniæ*, septal abnormalities have shown a certain difference in the arrangement of the cells and of the lobules on the two sides, so that the superior lateral lobe has, on one side, an isosceloid, on the other an anisosceloid terminal lobule. It is, however, a case of far greater differences than this being joined to great external similarity. The most striking example is shown in Pl. XCIV, in which figs. 1 and 3 illustrate two homœomorphous fossils, while figs. 2 and 4 show septa which are wonderfully distinct, the superior lateral lobe of fig. 4 being short, tridactyloid, symmetrical, with isosceloid, equicellate terminal lobule; that of fig. 2 being long, tetradactyloid, asymmetrical, with terminal lobule intra-axial, inequicellate, and outer lobule deeply bipartite.

The following scheme having been decided upon, it was considered advisable not to continue the description of the remaining new species, but to treat the whole series of *Concavum*-zone *Sonniniæ* together, introducing the new species where they fell in the scheme. It may be remarked that a bilaterally symmetrical cruciform superior lateral lobe (see Pl. CI, fig. 3) is taken as the archetype, from which the others are considered to have developed; but it is probable that, in the phylogenetic history, this type of lobe was preceded by a superior lateral lobe with ultra-axial, inequicellate, anisosceloid terminal lobule—the inner inter-lobular cell the deeper, making the terminal lobule ecto-brachysceles,[1] like that shown for *Zurcheria parvispinata* (Pl. L, fig. 10); and that in passing from the lobe with ultra-axial, inequicellate, ecto-brachysceles terminal lobule to the

time required for each specimen would be very great. So far, in my experience, the tracing-off processes are much the most expeditious—though in the case of complicated septa the time may be reckoned by hours,—and the errors are not so much in the work of tracing and drawing, but in the first marking out on the fossil.

The above remarks are made in answer to certain queries as to a royal road to do suture-lines. There is no royal road: it is a tedious process at best, and very trying to the eyesight.

[1] Βραχυσκελής, short-legged; ἐκτὸς, outside; ἔνδον, within. The shorter leg on the outer side or on the inner side as the case may be (see p. 382).

lobe with intra-axial, inequicellate, endo-brachysceles terminal lobule, the lobe with axial, equicellate, isosceles terminal lobule would be a necessary phase.

Primarily, then, the differences between the septa of the various series is whether the symmetrical, axially lobulate lobe was persistent throughout catagenesis as in the *quadrifida*-stock, or whether the asymmetrical, intra-axially lobulate lobe makes its appearance early in catagenesis, or even before the period of phyletic decline had begun. It is the possibility of the symmetrical passing into the asymmetrical lobe at any stage in phyletic development which makes it so difficult to correctly and concisely define the differences between the various series. In all cases it is necessary to insist on the comparison of septa of species in the same stages of phyletic development,—for instance, of spinous species with spinous species, and so on; or, in other words, in considering differences of septation morphic equivalents must always be compared.

In order to facilitate the study of the following classification, skeleton outlines of the various types of superior lateral lobe have been prepared by actual tracing of the general outline in each case. The denticulations have been disregarded; and all that it is sought to illustrate is the disposition of the lobules which, when well developed, constitute the somewhat cruciform arrangement so characteristic of all these fossils, or that asymmetrical departure from such arrangement which is equally striking. In the main the cause of the departure seems to be the necessity for greater support of the area beyond the superior lateral lobe consequent on the acquirement of less gibbous whorls.[1] It will be noticed in the first place that in the different stocks these flatter whorls are acquired earlier or later in relation to other characters—say spinosity; that the asymmetry of L[2] is also acquired at different times in relation to the flatter whorls, or it may not be acquired at all. However, the difference in time of acquirement, reckoned in regard to other characters, becomes a point of distinction between two forms, and between the forms of two stocks; and further, the differences give rise to a different degree of asymmetry in correlation with the same degree of some other character.

As it is by no means easy to make this intelligible to those who have not tried to study the matter from the same point of view, it may be desirable to attempt the following method of explanation. Let $x =$ the degree of spinosity, $y =$ the degree of gibbosity, $z =$ the degree of asymmetry of L; z at starting being practically symmetrical. Then the characters of the first species (A) may be represented by the formula $x + y + z$. But the characters of the second species (B) compared to those of A must be written $\frac{x}{2} + \frac{y}{2} + z$, and the characters of a third species (C)

[1] See p. 138.

[2] The following abbreviations will be used; they are not new to Ammonite literature:—$L =$ superior lateral lobe; $l =$ inferior lateral lobe.

must be placed as $\frac{x}{4} + \frac{y}{4} + 2z$. Another species, say B′, has, when compared with A, characters like this, $\frac{x}{2} + \frac{y}{3} + 2z$; and a further species, C′, has a formula $\frac{x}{4} + \frac{y}{4} + 4z$. When, therefore, B and B′ are compared together, it is found that each has the same degree of spinosity, but that B′ has twice the degree of asymmetry of *L* which B has; and when C is compared with B′ it is found to have the same degree of asymmetry of *L*, but coupled with half the degree of spinosity and a less degree of gibbosity. If, then, x degree of spinosity be taken as the starting-point, C must be said to have acquired its degree of asymmetry later than B′ in relation to the spinosity; because B′ had only got its spinosity reduced one-half when it had acquired $2z$ degree of asymmetry of *L*, whereas C has got its spinosity reduced one-fourth before it acquired $2z$ degree of asymmetry of *L*. It is this consideration which has been the guiding principle of the following classification. Although possessing the same degree of asymmetry of *L*, C and B′ would be ranged in different stocks, because it would be considered that C acquired its asymmetry of *L* later than B′. In fact, these species would be arranged in this manner to show what is taken to be their genealogy, having regard to such characters:

$$x + y + z \begin{array}{l} \nearrow \frac{x}{2} + \frac{x}{2} + z \;\text{———}\; \frac{x}{4} + \frac{y}{4} + 2z. \\ \searrow \frac{x}{2} + \frac{y}{3} + 2z \;\text{———}\; \frac{x}{4} + \frac{y}{6} + 4z. \end{array}$$

In order to facilitate as much as possible the study of the species of *Concavum*-zone *Sonniniæ*, their classification is first given in a skeleton form. Further, the skeleton outlines of the principal types of *L* have been inserted in this classification so that the reader can see the character on which the scheme is mainly based. The names of the species belonging to each subdivision are placed in their order, and references to the pages where they are mentioned are attached to them. The species which have been already described bear two references—the earlier one relating to the previous description, the later one to any additional note that has become necessary. New species bear only one reference each, namely, the number of the page where they are described. By such means the whole classification is brought into a small compass, readily available to the reader for examination and comparison; it is also a suitable introduction to the more detailed specific articles which follow.

AN OUTLINE OF THE CLASSIFICATION OF THE *CONCAVUM*-ZONE *SONNINIÆ.*

I. The terminal lobule of *L* is axial in the spinous stage, and generally isosceloid.

A. The terminal lobule remains axial during phyletic development.

A. The lateral lobules of L *equipoised, isometric, non-partite.*

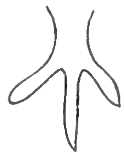


FIG. 4.—Outline of *L* of *Sonn. dominatrix.*

α. Costæ strong.

SONNINIA DOMINATRIX. (Page 392.)

β. Costæ weak.

SONN. TRIDACTYLA. (Page 393.)

B. The lateral lobules of L *isometric, bipartite.*

FIG. 5.—Outline of *L* of *Sonn. papilionacea.*

SONN. SPINOSA. (Pages 365 and 394.)
SONN. QUADRIFIDA. (Pages 366 and 394.)
SONN. PAPILIONACEA. (Pages 367 and 394.)

B. The terminal lobule of *L* becomes slightly intra-axial.

A. Lateral lobules of L *short and both bipartite.*

FIG. 6.—Outline of *L* of *Sonn. costata.*

a. Lobe narrow-stemmed.

SONN. SCALPTA. (Pages 376 and 394.)

β. Lobe wide-stemmed.

SONN. COSTATA. (Pages 338 and 395.)

B. *Lateral lobules of* L *fairly developed.*

a. Lateral lobules remain nearly isometric.

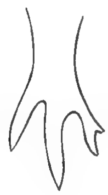


FIG. 7.—Outline of *L* of *Sonn. parvicostata.*

SONN. REGULARIS. (Page 395.)
SONN. PARVICOSTATA. (Pages 339 and 396.)
SONN. UMBILICATA. (Page 397.)

β. Lateral lobules become distinctly anisometric.

1. *Terminal lobule isosceloid.*

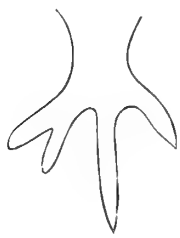


FIG. 8.—Outline of *L* of *Sonn. crassa.*

SONN. CRASSA. (Pages 350 and 398.)

2. *Terminal lobule anisosceloid.*

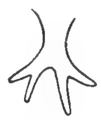


FIG. 9.—Outline of *L* of *Sonn. diversa.*

SONN. CRASSICOSTATA. (Pages 354 and 398.)
SONN. DIVERSA. (Pages 355 and 399.)
SONN. LÆVIGATA. (Pages 356 and 399.)

γ. Inner lateral lobule in duplicate.

FIG. 10.—Outline of *L* of *Sonn. crassibullata.*

SONN. CRASSIBULLATA. (Pages 353 and 400.)
SONN. INÆQUA. (Page 400.)

δ. Outer lateral lobule in duplicate.

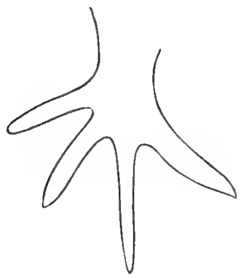


FIG. 11.—Outline of *L* of *Sonn. crassiformis.*

1. *Lobes long and ornate.*

SONN. CRASSIFORMIS. (Pages 348 and 401.)
SONN. NUDA. (Pages 352 and 402.)

2. *Lobes somewhat short, not very ornate.*

SONN. DUPLICATA. (Page 402.)
SONN. CAMURA. (Page 403.)

II. The terminal lobule of *L* is intra-axial in the spinous species, and generally anisosceloid.

A. The lobes and lobules are short and broad-stemmed.

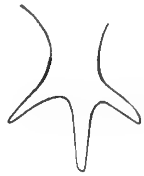


FIG. 12.—Outline of *L* of *Sonn. spinea.*

A. These characters are well marked.

a. Costæ irregular.

SONN. ABNORMIS. (Pages 377 and 404.)

β. Costæ regular.

1. *Correlated umbilication considerable.*

SONN. EUROMPHALICA. (Pages 362 and 405.)
SONN. OMPHALICA. (Pages 363 and 405.)

2. *Correlated umbilication not so considerable, and ornament rather less.*

SONN. SPINICOSTATA. (Pages 337 and 405.)
SONN. SPINEA. (Page 405.)
SONN. SUBMARGINATA. (Pages 329 and 406.)
SONN. SUBSTRIATA. (Pages 330 and 406.)

B. L *scarcely so short and broad-stemmed.*

SONN. NODATA. (Pages 369 and 407.)
SONN. MARGINATA. (Pages 321 and 407.)
SONN. PAUCINODATA. (Pages 370 and 408.)
SONN. ATTRITA. (Pages 371 and 408.)

B. The lobes are fairly long.

A. The lobes are rather wide-stemmed.

FIG. 13.—Outline of *L* of *Sonn. dominata.*

SONN. DOMINATA. (Page 408.)
SONN. CONTUSA. (Page 409.)

B. The lobes are narrow-stemmed.

α. The lateral lobules decidedly anisometric.

1. *The outer lobule about as large as the terminal lobule.*

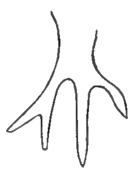


FIG. 14.—Outline of *L* of *Sonn. dominica.*

SONN. DOMINICA. (Page 410.)
SONN. MULTICOSTATA. (Page 410.)

2. *The outer lobule excessively exaggerated, larger than the terminal lobule.*

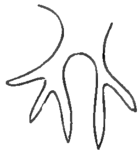


FIG. 15.—Outline of *L* of *Sonn. palmata.*

SONN. PALMATA. (Pages 372 and 412.)

C. The lobes are long, but lobes or lobules may degenerate in phyletic development.

A. *The lobes remain long, and asymmetry is not pronounced.*

a. Lateral lobules fairly developed.

FIG. 16.—Outline of *L* of *Sonn. subdecorata.*

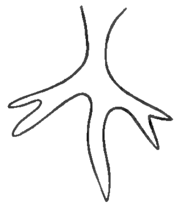


FIG. 17.—Outline of *L* of *Sonn. magnispinata.*

1. ***Ribs reclinate.***

* Spines small.

SONN. SUBSPINOSA. (Pages 358 and 412.)
SONN. DECORATA.[1] (Pages 360 and 412.)
SONN. SUBDECORATA. (Pages 361 and 412.)
SONN. DECORA. (Pages 361 and 412.)

** Spines large.

SONN. MAGNISPINATA. (Pages 341 and 413.)
SONN. BREVISPINATA. (Pages 343 and 414.)

2. *Ribs fairly upright.*

SONN. MUTANS. (Page 414.)
SONN. SUBCOSTATA. (Pages 330 and 415.)

[1] Suture-line unknown.

β. Lateral lobules short.

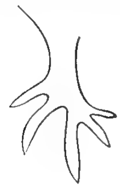


FIG. 18.—Outline of *L* of *Sonn. plicata.*

SONN. PLICATA. (Page 415.)
SONN. SEMISPINATA. (Pages 343 and 416.)

γ. Lateral lobules rather long, outer bipartite.

FIG. 19.—Outline of *L* of *Sonn. revirescens.*

SONN. REVIRESCENS. (Pages 324 and 417.)

δ. Outer lateral lobule of *L* strongly bipartite.

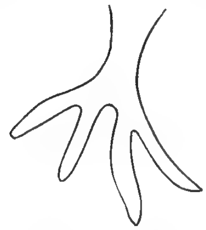


FIG. 20.—Outline of *L* of *Sonn. biplicata.*

SONN. IRREGULARIS. (Pages 320 and 417.)
SONN. BIPLICATA. (Pages 345 and 417.)

B. The lobes become short in catagenesis.

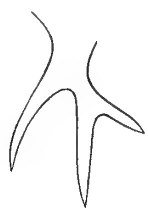


FIG. 21.—Outline of *L* of *Sonn. ptycta.*

a. Costæ weak.

SONN. SPINIFERA. (Pages 335 and 418.)

β. Costæ strong.

SONN. ACANTHODES. (Pages 319 and 419.)
SONN. PTYCTA. (Pages 332 and 420.)
SONN. CYMATERA. (Pages 332 and 420.)

C. The lobes remain long, but L *becomes very asymmetrical.*

a. Inner lobule of *L* much abbreviated in spinous species.

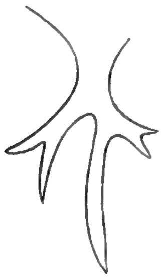


FIG. 22.—Outline of *L* of *Sonn. gibbera.*

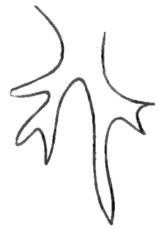


FIG. 23.—Outline of *L* of *Sonn. modesta.*

1. *Costæ regular.*

SONN. RECLINANS. (Page 421.)
SONN. GIBBERA. (Page 421.)
SONN. MODESTA. (Pages 325 and 422.)
SONN. SIMPLEX. (Pages 326 and 423.)

2. *Costæ paired.*

SONN. ALTERNATA. (Pages 346 and 424.)

β. Inner lobule of *L* not abbreviated in spinous species (but it is so later on in the phyletic series).

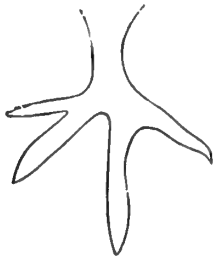


FIG. 24.—Outline of *L* of *Sonn. subirregularis.*

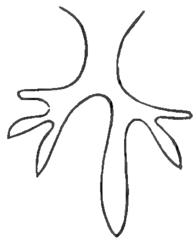


FIG. 25.—Outline of *L* of *Sonn. subsimplex.*

SONN. MULTISPINATA. (Pages 317 and 425.)
SONN. CRASSISPINATA. (Pages 317 and 425.)
SONN. SUBIRREGULARIS. (Page 426.)
SONN. SUBSIMPLEX. (Pages 328 and 427.)

D. The lobes are decidedly long, and there is little degeneration of lobes or lobules in phyletic development.

A. The lobes are fairly developed.

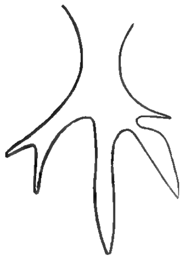


FIG. 26.—Outline of *L* of *Sonn. costigera.*

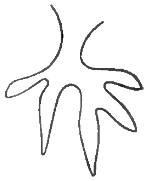


FIG. 27.—Outline of *L* of *Sonn. obtusiformis.*

SONN. COSTIGERA. (Page 428.)
SONN. OBTUSIFORMIS. (Pages 333 and 430.)

B. The lobes are remarkably well developed, and the septa are much interlocked.

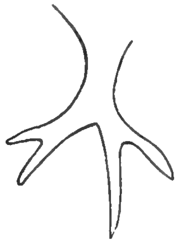


FIG. 28.—Outline of *L* of *Sonn. renovata.*

SONN. LOCUPLES. (Page 431.)

a. The outer lobule of *L* non-partite or feebly bipartite.

SONN. RENOVATA. (Page 433.)
SONN. REFORMATA. (Page 434.)

β. Outer lobule of *L* strongly bipartite.

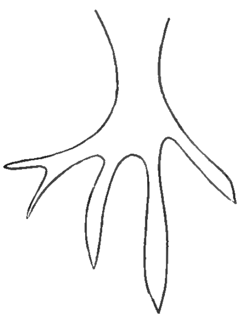


FIG. 29.—Outline of *L* of *Sonn. dominans.*

SONN. DOMINANS. (Pages 322 and 435.)
SONN. LOCULOSA. (Page 437.)

The above is the skeleton classification. The following pages give a more detailed account of the species arranged on the same plan, with descriptions of those which are new, and supplementary notes where necessary to those previously described. The absence of a back reference will distinguish the new species.

A detailed classification of the *Sonniniæ* of the *Concavum*-zone.

I. The terminal lobule of *L* is axial in the spinous stage of the phyletic series, and generally isosceloid.

A. The terminal lobule remains axial during phyletic development.

A. The lateral lobules equipoised, isometric, non-partite.

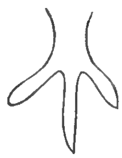


Fig. 30.—Outline of *L* of *Sonn. dominatrix.*

a. Costæ strong.

Sonninia dominatrix, *S. Buckman.* Plate XCIV, figs. 3 and 4; Plate XCV, fig. 2.

1892. Sonninia dominans δ. This Monograph, p. 323.

Discoidal, compressed, hollow-carinate. Whorls ornamented with direct, nearly upright, ventrally-inclined, increasingly prominent, on the median area subbullate costæ. (A regular spinous stage to about 15 mm. shell-diameter; then a slightly irregular spinous stage to about 25 mm. shell-diameter, and for about half a whorl further a stage with spinicostæ and costæ as 1 to 2.) Ventral area arched, somewhat flattened, divided by a small, rounded, fairly-defined carina. Inner margin broad, well-defined, nearly upright, flat. Inclusion about one-third. Umbilicus somewhat deep, regularly graduate. Whorl-section gibbous-sided, oblong. Suture-line with short lobes; *L* symmetrical, the terminal lobule axial, isosceloid, equicellate; the lateral lobules equipoised, isometric, non-partite.

From *Sonn. dominans* this form differs in being much more costate, and in commencing the coarse distant ribs earlier in life. It has further a suture-line with shorter lobes, and the superior lateral lobe more equally balanced—the lateral lobules being practically isometric. This seems to be a not uncommon form of the Bradford Abbas *Concavum*-bed; but then there are other species of

similar appearance which have very different septa; and with one of these (see Pl. XCIV, figs. 1, 2) the present form has been placed on the same plate for comparison. Side view reduced to two-thirds natural size is shown in Pl. XCIV, fig. 3; septal margin, fig. 4; outline of front view, fig. 2 of Pl. XCV.

β. Costæ weak.

SONNINIA TRIDACTYLA,[1] *S. Buckman.* Plate CI, figs. 1—3.

Discoidal, compressed, hollow-carinate. Whorls ornamented with alternate costæ and spinicostæ, later with not prominent, nearly direct, ventrally-inclined, alternate large and small costæ,—the small, which gradually become obsolete, representing the previous costæ; the larger, the previous spinicostæ. Ventral area arched, divided by a small, fairly-defined hollow carina. Inner margin fairly defined, nearly upright. Inclusion about two-fifths, up to the spines. Umbilicus concentric, graduate, ornamented with a regular spinous stage up to 24 mm. diameter (diameter of shell about 35 mm.), later with alternate costæ and spinicostæ. Whorl-section gibbous-sided, oblong. Septa with somewhat short lobes, *L* symmetrical, its terminal lobule axial, isosceloid, equicellate, its lateral lobules equipoised, nearly isometric.

This specimen is presumably immature. The ornamentation of the inner whorls, the septa, and the compression suggest relationship with *Sonn. spinosa;* and the two former characters also have resemblance to those seen in *Sonn. crassibullata.* The wider stem of the superior-lateral lobe and the shorter terminal lobule seem to be against direct genetic connection with *Sonn. spinosa.* The paucity of costation rather favours connection with *Sonn. crassibullata*, but the septation negatives this idea.

If all its details be taken in consideration, it is difficult to confound this species with any of those figured. From *Sonn. spinifera*, which it somewhat resembles, the longer spinous stages distinguish it externally, while the symmetrical *L*, with axial terminal lobule, is a decided internal difference. From *Sonn. crassinuda* a larger umbilicus and more pronounced ornament separate it; from *Sonn. lævigata* greater spinosity and more pronounced ornamentation, as well as the symmetry of the superior lateral lobe, are features of distinction.

In septation this form agrees with *Sonn. dominatrix.* It is, however, more umbilicate, and more compressed ventrally; it has much longer and more marked

[1] Τριδάκτυλος, three-fingered, in reference to the superior lateral lobe.

spinous stages, and less marked more distant costæ. This form occurs in the *Concavum*-zone of Bradford Abbas. Its side-view is depicted of natural size in Pl. CI, fig. 1; the outline of its whorl-section in fig. 2; outlines of parts of two septa, fig. 3.

B. The lateral lobules of *L* isometric, bipartite.

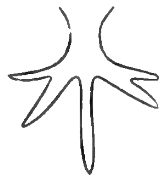


FIG. 31.—Outline of *L* of *Sonn. papilionacea.*

SONNINIA SPINOSA, *S. Buckman.* See Pl. LXXXI, figs. 7—9, and page 365.
— QUADRIFIDA, *S. Buckman.* See Pl. XCI, figs. 1—3, ,, ,, 366.
— PAPILIONACEA, *S. Buckman.* See Pl. XC, figs. 1—3, ,, ,, 367.

The above species form the *quadrifida*-stock (see page 364), and their septation is very remarkable.

B. The terminal lobule of *L* becomes slightly intra-axial.

A. Lateral lobules of *L* short and both bipartite.

FIG. 32.—Outline of *L* of *Sonn. costata.*

a. Lobe narrow-stemmed.

SONNINIA SCALPTA, *S. Buckman.* See Pl. LXXXVII, figs. 1—3, and page 376.

β. Lobe wide-stemmed.

SONNINIA COSTATA, *S. Buckman*. See Pl. LXXIV, fig. 1; Pl. LXXV, figs. 1, 2, and page 338.

In *Sonn. scalpta* and *Sonn. costata* the lateral lobules are so divided that they might almost be said to be double, and the species might almost be described as possessed of four lateral lobules to *L*. In addition to the septation, *Sonn. scalpta* is distinguished from *Sonn. costata* by the much larger umbilicus and the smaller, more numerous costæ, in some places as 4 to 3; but the reduction in the figure of *Sonn. costata* may perhaps mislead in these points.

B. Lateral lobules of *L* fairly developed.

a. Lateral lobules remain nearly isometric.

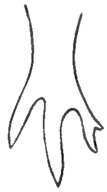


Fig. 33.—Outline of *L* of *Sonn. parvicostata*.

SONNINIA REGULARIS, *S. Buckman*. Plate XCVI, figs. 3—5.

1892. SONNINIA MARGINATA, *S. Buckman*. This Monograph, Plate LXIV only (?)[1].

Discoidal, compressed, hollow-carinate. Whorls ornamented with spinicostæ, with costæ and spinicostæ 2 or 3 to 1, and then with close-set, direct, slightly reclining costæ, inclined but obscure ventrally. Ventral area arched, divided by a well-defined, somewhat massive hollow carina. Inner margin conspicuous, broad, nearly flat, nearly upright. Inclusion one-third. Umbilicus concentric, regularly graduate, inner whorls spinous, regular spinous stage until the shell-diameter is about 40 mm., irregular to about 70 mm. Suture-line with a fairly symmetrical *L*, the terminal lobule practically axial, equicellate, isosceloid; the lateral lobules nearly isometric, opposite; an accessory lobule on each side of the stem, above the usual lateral lobules; the inferior lateral lobe with two lateral lobules each side.

[1] It is requested that the explanation of the plate be altered in accordance.

The above description applies only to the type-form depicted in Plate XCVI, figs. 3—5. It is necessary, however, to remove from *Sonn. marginata* the large specimen figured in Pl. LXIV on account of differences in septation; and it is assumed that that form is the adult of *regularis*. Such differences as there are in septation may be supposed to be due to difference in age. This, however, cannot be assumed in regard to that large specimen and *Sonn. marginata*, because continued compression of the whorl favours the change from a symmetrical to an asymmetrical *L*; whereas a contrary change, from marked asymmetry to greater symmetry, would have to be conceded, if the large specimen in Pl. LXIV be considered to be the same species as *Sonn. marginata* (Pl. LXII).

The type *Sonn. regularis* differs from *Sonn. marginata* externally by its more prominent, altogether more massive carina, by its thicker whorls and its stronger spinous stages. Internally, as to septation, the differences are still more marked, for the septa of *Sonn. marginata*, which have been exposed since the type was figured and are now placed in Pl. XCVI, fig. 6, for comparison, show asymmetrical *L* with distinctly intra-axial, markedly anisosceloid, and inequicellate terminal lobules.

Sonn. regularis occurs in the *Concavum*-zone of Bradford Abbas. The side view of a fairly preserved shell with test present is depicted of natural size in Pl. XCVI, fig. 3; its whorl-section, with part of embraced whorl, in outline, fig. 4; the portions of two septa, fig. 5.

SONNINIA PARVICOSTATA, *S. Buckman*. Plate CIII, fig. 22.

See Plate LXXV, figs. 3—5; Plate LXXIV, figs. 2, 3, and page 339.

It is a long step from *Sonn. regularis* to this species; the only bond between them is the similarity of the septation to that of *Sonn. regularis*, adult (*antea S. marginata*), Pl. LXIV. The likeness in certain respects between *Sonn. costata* and this species would warrant their connection; but certain differences in septation necessitate their separation in this scheme. These species, however, seem to be near relations; but the evidence of the septa appears to suggest that the genetic connection is not so direct as was assumed when they were first described.

SONNINIA UMBILICATA, *S. Buckman.* Plate LXXXIV, figs. 1—3.

Discoidal, compressed, carinate. Whorls ornamented with direct, not very conspicuous, nearly upright, ventrally-inclined (almost ventrally-projected) costæ. Ventral area rounded, divided by a small carina. Inner margin fairly defined, sloping. Umbilicus open, ornamented with ribs, no spinous stage being discernible. Whorl-section oblong. Suture-line simple with a superior lateral lobe of moderate length, the lateral lobules anisometric, the terminal lobule slightly intra-axial, isosceloid, scarcely equicellate.

This form is like *Sonn. parvicostata.* It has, however, a flatter, larger umbilicus, more compressed whorls, and more pronounced costation. Its suture-line agrees fairly with that of *Sonn. parvicostata,* except that the lateral lobules of the superior lateral lobe are somewhat more anisometric. The various points of similarity detailed above suggest the position of this species.

From *Sonn. omphalica* the septation, and the want of spines[1] distinguish this species; it has also more compressed whorls and smaller ribs. The septation negatives any idea of genetic connection between *S. umbilicata* and *S. omphalica;* but the other features would not—in fact, they rather suggest it.

Sonn. umbilicata is from the *Concavum*-zone of Bradford Abbas, Dorset.

Side view, front view, and suture-line are illustrated in Pl. LXXXIV, figs. 1—3. The specimen is possessed of test.

β. Lateral lobules become distinctly anisometric.

1. Terminal lobule isosceloid.

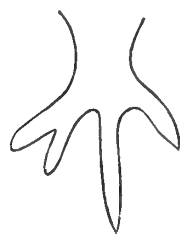


FIG. 34.—Outline of *L* of *Sonn. crassa.*

[1] It is reasonable to assume a spinous stage in the innermost whorls, but it must have ended very early.

SONNINIA CRASSA, *S. Buckman.* Plate C, fig. 10.
See Plate LXXXII, figs. 1, 2, and page 350.

Add to description:—Suture-line with fairly long lobes; with slightly intra-axial, isosceloid, terminal lobule, lateral lobules slightly anisometric, the outer distinctly bipartite.

2. Terminal lobule anisosceloid.

FIG. 35.—Outline of *L* of *Sonn. diversa.*

SONNINIA CRASSICOSTATA, *S. Buckman.* Plate CIII, fig. 18.
See Plate LXXX, figs. 4—6, and page 354.

Add to description:—Suture-line of type with lobes fairly long; *L* with axial, ectobrachysceles terminal lobule, and practically isometric lateral lobules.

The suture-line of the type is somewhat abnormal, and hardly seems to warrant the present position of the species. The terminal lobule of *L* is ecto-brachysceles, whereas in the outline given above (fig. 35) the terminal lobule is anisosceloid by reason of being endo-brachysceles.

Perhaps the ecto-brachysceles character in the type is due to an exceptional development of an accessory lobule beyond (above) the outer lateral lobule and at its expense; and that normally the suture-line of the species more nearly conforms to that shown in Pl. LXXX, fig. 6. That is from an older allied form, and shows an isosceloid terminal lobule. That suture-line, however, does not agree with what is stated above (No. 2), for that reason; but it is of a pattern like that of fig. 34. There is every possibility of both these developing asymmetry like fig. 35; and therefore the word " become " has been used above, at β. It is the aim of this scheme to avoid the common error of grouping morphic equivalents; its object is to bring together the species which are assumed to be genetically connected, and to use as differentials the points wherein they diverge from their neighbours during phyletic development.

Septation alone would group this species with *Sonn. regularis* or *Sonn. crassa.* The strong costation which follows the spinous stage of that species, and the weak costation which follows the same stage in this form, prevent its being considered with them. It is this character of weak costation which connects this species with the succeeding forms.

Sonninia diversa, *S. Buckman.* Plate CIII, fig. 8.
See Plate LXXXIII, figs. 1—4; Plate LXXXI, figs. 5—6, and page 355.

Add to description:—Suture-line of the type-form with fairly long lobes; *L* with intra-axial, anisosceloid terminal lobule and anisometric lateral lobules.

Sonninia lævigata. Plate CI, figs. 7—9 (variety); Plate CIII, fig. 9.
See Plate LXXXII, figs. 5, 6, and page 356.

Add to description:—Suture-line of type hardly to be followed with certainty; *L* with very anisosceloid terminal lobule, the lobe presumably degenerate. Suture-line of variety: *L* with anisosceloid terminal lobule, anisometric lateral lobules, outer distinctly tripartite.

The form considered to be a variety is slightly more spinous in the umbilicus than the type. If the suture-line shown by the type be considered to indicate septal degeneration—and this may possibly have begun in this degenerate form—then the suture-line of the variety may be thought to show the pattern of the septa before degeneration commenced. In outline it agrees fairly—allowance being made for difficulty in tracing the septa of the type.

The variety came from Stoke Knap, near Broad Windsor, Dorset, doubtless from the *Concavum*-zone. It was obtained by Mr. E. Wilson, F.G.S., who very kindly allowed me to add it to my collection.

Sonninia crassinuda, *S. Buckman.* See Plate LXXXI, figs. 1—4, and page 351.

The septa are unknown, but external characters (see page 348) seem to place the species here in connection with *Sonn. crassicostata.*

γ. Inner lateral lobule in duplicate.

FIG. 36.—Outline of *L* of *Sonn. crassibullata.*

SONNINIA CRASSIBULLATA. Plate CIII, fig. 17.
See Plate LXXX, figs. 1—3, and page 353.

It is probable that the suture-line of the type is abnormal, so far as regards the duplication of the inner lateral lobule of *L*. If the upper of the two lateral lobules were absent, and if there were a corresponding increase in the size of the lower one, the septation would be in agreement with that of the foregoing series.

In the suture-line shown in Pl. LXXX, fig. 3, there is a general agreement with those of the foregoing species; but here, again, there is a feature presumably abnormal for these *Sonniniæ*, namely, an ultra-axial position of the terminal lobule of *L*.

SONNINIA INÆQUA, *S. Buckman.* Plate CI, figs. 4—6.

Discoidal, compressed, carinate. Whorls ornamented with inconspicuous, subundulate, slightly subsigmoid, reclinate[1] costæ, inclined but obscure ventrally. Ventral area arched, divided by a small, rounded, doubtfully hollow carina, less conspicuous with age. Inner margin sloped, subconvex, fairly defined. Inclusion one-half. Umbilicus graduate, slightly excentric, ornamented with small costæ closely set in the central whorls, apparently destitute of spines.[2] Whorl-section oblong. Septa somewhat ornate, the superior lateral lobe asymmetrical, the lateral lobules anisometric, the outer lobule larger than the inner, incipiently tripartite; the terminal lobule intra-axial, very anisosceloid, and very inequicellate; the inner lobule small; and beyond the inner lobule an extra lobule is projected from the main stem of the lobe.

[1] More upright with age.

[2] Up to about 8 mm. of umbilical diameter the whorls are badly preserved.

In external shape *Sonn. inæqua* has much resemblance to *Sonn. costata;* but it differs from the form of that species in being so much less costate, and in having a less angular, more rounded ventral area. Internally, in septation it differs considerably—the superior lateral lobe is more asymmetrical, the terminal lobule is far more anisosceloid, the lateral lobules are anisometric. There is a certain likeness in septation to *Sonn. crassibullata*—the inner lobule in both species is, in a sense, double, a feature which is peculiar to these two forms. In other characters they do not at all show that agreement which direct genetic relationship would produce.

Mr. E. Wilson, F.G.S., kindly gave me the figured specimen which he recently obtained from Stoke Knap, near Broad Windsor, Dorset. A specimen from Bradford Abbas, which agrees with this in the feeble costation, in the septation, and in the matter of the arched periphery—and had in consequence of these features been separated from *Sonn. costata*—must evidently be placed with the present species, though it is the least trifle thicker. It shows a quarter-whorl body-chamber, and attains the diameter of 190 mm.

ε. Outer lateral lobule in duplicate.

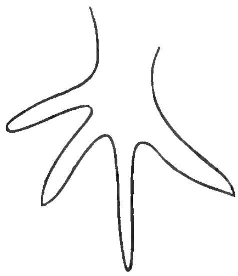


FIG. 37.—Outline of *L* of *Sonn. crassiformis.*

1. Lobes long and ornate.

SONNINIA CRASSIFORMIS, *S. Buckman.* See Plate LXXIX, figs. 1—6, and page 348.

In this species there are two outer lateral lobules to *L* (Pl. LXXIX, fig. 6); in other words the outer lobule is cleft to its base. In *Sonn. crassa* the outer lobule is only cleft about half way.

SONNINIA NUDA, *S. Buckman.* Plate CIII, fig. 10.
See Plate LXXXII, figs. 3, 4, and page 352.

Add to description :—Suture-line of the type with long lobes, *L* with a long, slightly intra-axial, isosceloid terminal lobule, and an outer lobule bipartite to its base, making the outer lobule duplicate.

The suture-line of this form agrees with that of *Sonn. crassiformis* in having the outer lateral lobule of *L* cleft to the base, and in other features. As the outer lateral lobule of *L* in *Sonn. crassa* is only half-cleft, that species can scarcely be placed in direct genetic connection between *crassiformis* and *nuda;* because it is presumed that a lateral lobule of *L* bipartite to the base is a further development than a lateral lobule only partially bipartite.

The foregoing forms, from *crassicostata* (p. 398) to this species, excluding *inæqua*, were included as the *crassa*-stock (p. 347). The above study of their septation confirms their close relationship, but it shows that in the *crassa*-stock there were more than two branches.

2. Lobes somewhat short, not very ornate.

SONNINIA DUPLICATA, *S. Buckman.* Plate XCIX, figs. 1—3.

Discoidal, compressed, hollow-carinate. Whorls ornamented with long, slender, regular spines to about 40 mm. diameter; with plain costæ and irregular spinicostæ, as 2 or 3 to 1, to about 85 mm. diameter; with subarcuate, reclining, ventrally-inclined, irregular-sized costæ, and occasional bullicostæ to 120 mm. diameter; lastly, with similar costæ roughly arranged in pairs, the pairs larger than their fellows, and obscurely connate on the inner third. Ventral area arched, divided by a small, fairly distinct hollow carina. Inner margin fairly marked after the irregular spinous stage, slightly subconvex. Inclusion one-third—not up to the spines of the irregular spinous stage. Umbilicus with gibbous whorls and long slender spines. Whorl-section subquadrate-oval. Suture-line with a tetradactyloid *L*, the outer lobule being bipartite, the terminal lobule slightly intra-axial but isosceloid and equicellate.

The somewhat irregular pairing of the ribbing distinguishes this species. This character is similar to what obtains in *Sonn. biplicata* (p. 345) and *Sonn. alternata* (p. 346). From the first the present species is distinguished by its septation—*L* being shorter, less ornate, and more symmetrical,—by the less reclinate

ribbing, a rather different whorl-section, stronger and more persistent spinosity, and rather less costation; from the second by greater spinosity, by a larger umbilicus, and by the coarser costation, as well as by septation.

Although the tetradactyloid character of *L* and its isosceloid terminal lobule are similar to the septal features of *crassiformis*, and suggest the present position for this species, yet the entirely different proportions and degree of ornament make it doubtful if the forms are closely connected genetically. It may be observed that the outer lateral lobule of *L* is hardly cleft to the base as in *crassiformis*.

Sonn. duplicata occurs in the *Concavum*-zone of Bradford Abbas. The side view of a specimen in which the spines have been saved in a fairly perfect state is shown in Pl. XCIX, fig. 1; its whorl-section in fig. 2; and its suture-line in fig. 3.

Sonninia camura, *S. Buckman*. Plate XCIX, figs. 4—6.

Discoidal, compressed, carinate. Whorls ornamented with small, closely-set, direct, ventrally-inclined costæ, which become larger and more distant after about 170 mm. diameter, until in old age they are large, somewhat distant, coarse folds. (The spinous stage ends at about 22 mm. diameter.) Ventral area rounded, divided by a small, inconspicuous, ill-defined carina. Inner margin well marked, broad, nearly upright, rather flat. Inclusion of half-grown shell two-fifths, diminishing in old age to one-fourth. Umbilicus very excentric—a small centre with a rapid and not regular increase. Suture-line[1] with a tetradactyloid *L*, the outer lateral lobule being in duplicate—cleft nearly to the base,—the terminal lobule slightly axial, isosceloid, equicellate.

Though the ribs are small and closely set, they are more conspicuous than those of *modesta*, and even in half-grown shells the difference is very marked; the umbilicus is also more excentric, the carina much less conspicuous. From *revirescens* this form differs especially in having a much more rudimentary spinous stage, a more excentric umbilicus, flatter whorls, and less marked costation.

The septal details are the reason for placing this species with *Sonn. duplicata*. Whether its ancestor had paired ribs is uncertain, the species is too far advanced in the phylogerontic stage to retain any evidence of such a phyletic phase. The irregular excentricity of the umbilicus which makes the end of the whorl almost hooked, and gives the shell a "scaphitoid" appearance, suggests the name "*camura*."

[1] From another specimen.

Partly on account of the considerable reduction, the figure does not fully show this peculiar curvature of the last quarter of the ultimate whorl, yet both the periphery and the inner margin have a decided bend at about 120 mm. shell-radius. Another specimen, 160 mm. in diameter, shows a similar bend at about 95 mm. shell-radius. It commences to enlarge its costæ rather earlier than the type, namely, at about 145 mm. diameter. This is the specimen which has furnished the suture-line.

The correlation of an increase in umbilication and costation in the gerontic stage of a phylogerontic species is interesting as showing a combination of features which usually belong to the commencement of a genetic cycle. Their occurrence in the present case seems to indicate a tendency to a recommencement of the cycle in the phylogerontic stage. As the increase in umbilication is connected with a narrowing of the whorl and no corresponding increase in thickness, this apparent renewal of progressive development is plainly degenerative, and may be considered in a sense pathological.

Sonninia camura occurs in the *Concavum*-zone of Bradford Abbas, but is somewhat scarce. The side view (Pl. XCIX, fig. 4) is considerably reduced; it is a copy from a photograph, and is $\frac{3}{10}$ of the original. The outline of the whorl-section (fig. 5) is of natural size; the suture-line (fig. 6) is from another specimen.

II. The terminal lobule of *L* is intra-axial in the spinous species, and generally anisosceloid.

A. The lobes and lobules are short and broad-stemmed.

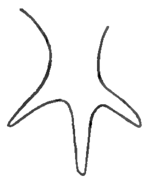


FIG. 38.—Outline of *L* of *Sonn. spinea.*

A. These characters are well marked.

a. Costation irregular.

SONNINIA ABNORMIS, *S. Buckman.* See Plate LXXXV, figs. 4—6, and page 377.

β. Costation regular.

1. Correlated umbilication considerable.

SONNINIA EUROMPHALICA, *S. Buckman.* See Plate LXXXV, figs. 1—3, and page 362.

SONNINIA OMPHALICA, *S. Buckman.* See Plate LXXXIII, figs. 5—9, and page 363.

2. Correlated umbilication not so considerable. Ornament rather less.

SONNINIA SPINICOSTATA, *S. Buckman.* See Plate LXXIII, figs. 4—6, and page 337.

Add to description :—Suture-line with short lobes ; *L* broad-stemmed and short, its terminal lobule intra-axial, anisosecloid, inequicellate ; its lateral lobules somewhat anisometric.

[*Note.*—In the text relating to this species (p. 337) the words " spines " and " spinous " are used in a general sense to include the knobs. The necessity for the distinction between spines, bullæ, and nodi had not then been felt, but it afterwards became imperative to introduce precise terms. The spinous stage, which is often mentioned in this work, included all tuberculated sub-stages—all stages when the costæ possessed anything like what the Wessex man calls " a rising." In future all these sub-stages may be advisedly united as the " tuberculate stage," and this stage may be " spinous," " spinicostate," " bullicostate," or " nodicostate." Further, in some forms to be treated later the nodus or bulla may be " sessile,"—that is, without any costa to support it ; or it may be " pedigerous,"—that is, carried on a costa or costæ ; literally " bearing a foot, or feet."]

A strict consideration of the septal details of this species in comparison with those of *costata* and *parvicostata* shows the necessity for its removal. These details agree so closely with those of species now placed in connection with this one, that there can be little doubt as to the present being its correct position.

SONNINIA SPINEA, *S. Buckman.* Plate LXXXVI, figs. 4—6.

Discoidal, compressed, hollow-carinate. Whorls ornamented with regular spines to about 40 mm. shell-diameter, with spinicostæ and costæ roughly alternate

to about 70 mm. diameter, with direct, undulate, reclined nodicostæ, or sometimes sub-bullicostæ, obscure but inclined ventrally. Ventral area arched, medianly flattened, divided by a fairly defined, small, rounded hollow carina. Inner margin scarcely defined, convex. Inclusion one-third. Umbilicus spinous with rather gibbous-sided whorls. Whorl-section gibbous-sided, quadrate-oblong. Suture-line latilobate; *L* nearly symmetrical, the terminal lobule slightly intra-axial, anisosceloid, inequicellate, the lateral lobules isometric.

This species resembles *Sonn. spinicostata;* and the likeness is exaggerated by the reduction of the figure of that fossil, and by the features of delineation noticed in the explanation of Pl. LXXIII. It differs in the strength of its ornamentation, the smaller size of the costæ, and the knobs on the costæ of the ultimate whorl nearly obsolete at a diameter when those of *spinicostata* are large and pronounced. In fact, in ornamentation this species with the test on is less ornate than *spinicostata* with the test off. The latter was evidently strongly knobbed to about 210 mm. diameter; in this species the knobs are very feeble at 85 mm. diameter. In septation there is but a slight difference; in *spinicostata* the terminal lobule of *L* is more anisosceloid, and the lateral lobules are anisometric.

Sonninia spinea occurs in the *Concavum*-zone at Bradford Abbas. It is illustrated in Pl. LXXXVI: fig. 4, side view; fig. 5, outline front view; fig. 6, suture-line.

Sonninia submarginata, *S. Buckman.* See Plate LXXI, figs. 1—3, and page 329.

Add to description:—Suture-line latilobate, *L* with slightly anisometric lateral lobules, terminal lobule intra-axial, anisosceloid, inequicellate.

Sonninia substriata, *S. Buckman.* Plate CIII, figs. 12, 13.
See Plate LXX, figs. 6, 7; Plate LXXI, figs. 6—8 (and ? Plate LXXII, figs. 1, 2), and page 330.

Add to description:—Suture-line of the type shows a broad, asymmetrical *L*, the terminal lobule anisosceloid, intra-axial, inequicellate, the lateral lobules anisometric.

Characters similar to the above are shown by the suture-lines of two other specimens (Pl. LXXI, fig. 8; Pl. CIII, fig. 12). The *L* of the type seems to indicate septal degeneration, but it is not in a good condition for being traced.

So far as the septation is concerned this species seems to agree fairly with

Sonn. submarginata. The lateral lobules are rather more anisometric, due to the abbreviation of the inner lobule, which, however, is a feature in the catagenesis of these series.

The specimen described as an intermediate form (Pl. LXXII, figs. 1, 2) may be considered near to this species until septal evidence to the contrary be forthcoming. It is on the whole similar in external appearance.

The *submarginata*-stock was considered to have sprung possibly from *S. marginata* (page 329), and the septal evidence now adduced has not altered this opinion very materially. It suggests, however, that *Sonn. spinicostata* and the new form, *Sonn. spinea,* belong here, that *subcostata* should be removed, and that *S. marginata* is a close ally in a slightly different genetic series.

B. L scarcely so short and broad-stemmed.

SONNINIA NODATA, *S. Buckman.* See Plate LXXXIX, figs. 1—5, and page 369.

Add to the explanation of the Plate (fig. 4), "Bradford Abbas, my Collection."

SONNINIA MARGINATA, *S. Buckman.* Plate XCVI, fig. 6.
See Plates LXII, LXIII, fig. 2, and LXV, figs. 1 and 2, and page 321.

From this species exclude the form figured in Pl. LXIV (see *Sonn. regularis*). Add to the description:—The suture-line has somewhat broad-stemmed lobes, *L* with intra-axial, anisosceloid terminal lobule, the lateral lobes isometric.

Of the specimens figured the smaller example (Pl. LXV, figs. 1 and 2) is slightly less spinous than the larger shell. In the printing of Pl. LXV the young form has obtained an appearance as if the costæ of the last half-whorl were slightly nodate, or perhaps subbullate. This, however, is incorrect; the ribs are slightly elevated in the middle, but the elevation is so gradual that nothing like a bulla is produced, still less is the shell nodicostate. The only feature of the former kind is seen just after the spinous stage: here, at distances apart equal to the former interspinous spaces, are two or three feeble sub-bullæ.

The septa suggest the present position of *S. marginata.*

SONNINIA PAUCINODATA, *S. Buckman.* See Plate XCI, figs. 7—9, and page 370.

SONNINIA ATTRITA, *S. Buckman.* See Plate XC, figs. 4—6, and page 371.

The last four species, with the exception of *Sonn. marginata*, formed the *paucinodata*-stock (p. 368). The *L* of the last is somewhat different from the others, but not much. This may be due to phyletic septal degeneration.

B. The lobes are fairly long.

A. The lobes are rather wide-stemmed.

FIG. 39.—Outline of *L* of *Sonn. dominata.*

SONNINIA DOMINATA, *S. Buckman.* Plate XCVII, figs. 1—3.

1892. SONNINIA DOMINANS (var. β). This Monograph, p. 323, *pars.*

Discoidal, compressed, carinate. Whorls ornamented with somewhat distant, not prominent, somewhat irregular-sized, direct, slightly reclining, ventrally-inclined costæ, some of which are occasionally connate on the inner third, and others obscure. (The regular spinous stage lasts to about 40 mm. diameter, the irregular spinous stage, with rather numerous spines, another half-whorl.) Ventral area obtusely arched, divided by a small, defined hollow-carina. Inner margin well defined, broad, slightly undercut, very slightly subconvex. Inclusion about three-tenths. Umbilicus open, concentric, regularly graduate. Whorl-section oblong-quadrate. Suture-line with short lobes; *L* asymmetrical, the lateral lobules anisometric, inner lobule short and narrow, outer rather broad, slightly bipartite, terminal lobule intra-axial, anisosceloid.

From *Sonninia dominans* this species is separable by being more spinous,

more umbilicate, more coarsely and distantly ribbed, and by having a more brevilobate, much less ornate, suture-line. From *Sonn. dominatrix* (p. 392) it is distinguished by being more spinous, more umbilicate, less costate, and by its asymmetrical *L*. In shape, umbilication, and spinosity it resembles *Sonn. dominica* (p. 410); but the irregularity of less prominent costæ, the greater thickness, and the more brevilobate suture-line lacking the subpendulous outer lobule of *L*, are points of distinction for this species.

Sonn. dominata occurs in the *Concavum*-zone of Bradford Abbas. It is illustrated in Pl. XCVII: fig. 1, side view; fig. 2, outline of whorl-section, both half natural size; fig. 3, portions of two septa.

Sonninia contusa, *S. Buckman*. Plate LXXXVIII, figs. 5—7.

Discoidal, compressed, carinate. Whorls practically smooth in adult except for some obscure irregularities. (Immature whorls with small, obscure, closely-set, direct costæ—details of centre not preserved.) Ventral area arched, divided by a small, ill-defined, rounded, obsolescent carina. Inner margin fairly defined, steeply sloped, flat. Inclusion about three-tenths. Umbilicus open. Suture-line with asymmetrical *L*, the terminal lobule intra-axial, anisosceloid; lateral lobules degenerate, anisometric.

The more concentric umbilicus separates this species from the other smooth, or nearly smooth forms. It is much thicker than *S. inæqua* (p. 400), with more squared-up whorls; it has a more concentric umbilicus, with deeper inner marginal walls; it is also smoother, and such costation as it possesses is more regularly disposed.

Sonn. contusa has a very degraded *L*, the lateral lobules being almost in a vestigial condition, and the cruciform arrangement of *L* being almost lost. The proportions suggest its association with *S. dominata*, and there is nothing in the superior lateral lobe to negative this.

This species occurs in the *Concavum*-zone at Bradford Abbas. It is illustrated in Pl. LXXXVIII: fig. 5, side view; fig. 6, outline front view, both one-half reduced; fig. 7, the superior lateral lobe.

B. The lobes are narrow-stemmed.

a. The lateral lobules decidedly anisometric.

1. The outer lobule about as large as the terminal lobule.

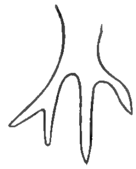


FIG. 40.—Outline of *L* of *Sonn. dominica.*

SONNINIA DOMINICA, *S. Buckman.* Plate CIII, fig. 14.

1892. SONNINIA DOMINANS, var. γ. This Monograph, Pl. LXIX,[1] p. 323, *pars.*

This species has already been figured in side view, outline of whorl-section, and suture-line; but the last has not come out very well in the printing of the plate, and accordingly it has been advisable to give another figure. This is furnished in Pl. CIII, fig. 14; and by removal of test additional details have been obtained.

The suture-line allows of the following description :—Lobes fairly long, *L* asymmetrical, the terminal lobule very intra-axial, anisosceloid, inequicellate, the lateral lobules very anisometric, the outer being about as large as the terminal lobule.

From *Sonninia dominans* type (Pl. LXVI) this form differs by being more spinous, more costate, and having a larger and more concentric umbilicus. Its suture-line has a more developed outer lobule to the superior lateral lobe, making this lobe decidedly asymmetrical, and the lateral lobules are very decidedly anisometric by reason of excessive development of the outer one. The difference in ornament and proportion, coupled with a difference in septation, makes another name a necessity.

From *Sonn. submarginata* (pp. 329 and 406) this species differs in septation. It is also thicker, less umbilicate, more spinous in the umbilicus, rather more strongly and more regularly costate.

SONNINIA MULTICOSTATA, *S. Buckman.* Plate LXXXVI, figs. 1—3.

Discoidal, compressed, carinate. Whorls ornamented in the brephic stage with a few very rudimentary irregular spines, which soon yield to direct, nearly upright, not very conspicuous, somewhat numerous ribs. Ventral area, in the neanic

[1] The reader is requested to alter the explanation of this plate accordingly.

stage, depressed, nearly flat across, and almost square to the lateral area, divided by a small, well-defined, presumably hollow carina; later, ventral area obtusely fastigate,[1] subcarinate, the two sides making an angle about 140°. Inner margin well marked, sloping, angle about 65°. Inclusion about one-half. Umbilicus graduate, ornamented with costæ. Whorl-section suboblong. Suture-line with fairly long lobes; *L* asymmetrical, with intra-axial, anisosceloid, inequicellate terminal lobule, and very anisometric lateral lobules.

It will be noticed that the suture-line of this species agrees in almost every particular with that of *Sonn. dominica.* There is the same tendency to make a somewhat bifid superior lateral lobe; there is the same large outer interlobular cell of *L*, but the inner lobule of *L* is more aborted, and another lobule proceeds from the inside just beyond it; further, the outer lobule is hardly so large as in *dominica*, but the difference is not great.

In ornamentation the agreement with *Sonn. dominica* is such as to justify the position which the suture-line suggests, namely, descendant of *Sonn. dominica.* There is the same series of close-set regular costæ; but they are smaller, and tend to be obsolete with age. There is a similar spinous stage; but it ends earlier, and is altogether less developed than in *dominica.* The whorl-shape is similar but more compressed. In fact, the points of difference, both in ornament and septation, are just those which might be expected in the descendant of *Sonn. dominica.*

Sonninia multicostata has some likeness to *S. euromphalica*, *S. omphalica*, and *S. submarginata;* but its peculiar suture-line separates it from any of them. Further, it is less spinous and less umbilicate than the first; thinner, more strongly carinate, and differently costate to the second; less spinous, differently costate, and less umbilicate than the third.

Sonn. multicostata occurs in the *Concavum*-zone of Bradford Abbas. It is depicted in Pl. LXXXVI of natural size; side view fig. 1, outline of front view fig. 2, suture-line fig. 3.

2. The outer lobule excessively exaggerated, larger than the terminal lobule.

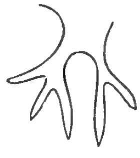


FIG. 41.—Outline of *L* of *Sonn. palmata.*

[1] *Fastigatus*, sloping like the roof of a house. The ventral area is bevelled on each side, and in section forms an inverted Λ.

SONNINIA PALMATA, *S. Buckman.* See Plate XC, figs. 7—9, p. 372.

This species has already been fully discussed. The features of its extraordinary superior lateral lobe are approached nearest by those of the two species last described. In the present case, however, there is far greater exaggeration of the outer lobule, so that *L* is almost bifid. In external ornament the form has but little likeness to the last two: the ribs are distant, somewhat irregular, and reclined.

C. The lobes are long, though lobes or lobules may degenerate in phyletic development.

A. The lobes remain long, and asymmetry of *L* is not pronounced.

a. Lateral lobules fairly developed.

FIG. 42.—Outline of *L* of *Sonn. subdecorata.*

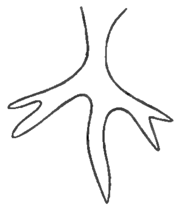


FIG. 43.—Outline of *L* of *Sonn. magnispinata.*

1. Ribs reclinate.

* Spines small.

SONNINIA SUBSPINOSA, *S. Buckman.* See Plate XLIX, figs. 8, 9; Plate LXXXIV, figs. 4—6, and page 358.

SONNINIA DECORATA, *S. Buckman:* See Plate LXXXIV, figs. 7, 8, and page 360.

The septal outline is still unknown. The species is placed here from its likeness in other features.

SONNINIA SUBDECORATA, *S. Buckman.* See Plate LXXXIV, figs. 9—11, and page 361.

SONNINIA DECORA, *S. Buckman.* See Plate LXXXIV, figs. 12—14, and page 361.

These last four species were described as the *subdecorata*-stock (p. 357). Their length of lobe almost suggests that they ought to be placed further on in this series.

** Spines large.

Sonninia magnispinata, *S. Buckman.* Plate XCVIII, figs. 1—3.
See Plate LXXVI, figs. 1—6, and page 341.

Since this species was figured and described I have worked out with much labour a specimen, long in my possession uncleaned.[1] When compared with *magnispinata*, Pl. LXXVI, it is seen to differ from the large specimen, figs. 4—6, in possessing nodiferous costæ on the outer whorl instead of merely plain costæ. Its whorl-section is also much more gibbous-sided, and its suture-line has a narrower-stemmed *L*. Compared with the *S. magnispinata* shown in figs. 1—3 (Pl. LXXVI), it appears to agree in every particular. The conclusion, therefore, is that the specimen shown in Pl. XCVIII, figs. 1—3, must be regarded as the adult of the specimen depicted in Pl. LXXVI, figs. 1—3, and that it is a typical *magnispinata*. On the other hand, the specimen illustrated in Pl. LXXVI, figs. 4—6, differs in certain respects, and may be placed provisionally as a variety. It may be noted as throwing doubt on this perhaps lenient view that there is much difference in the suture lines. The one shown in Pl. LXXVI, fig. 6, has *L* broad-stemmed, and the branching of the lobes and lobules does not by any means occupy the surface to the extent shown in fig. 3 of Pl. XCVIII. Here the *L* is longer and also quite narrow-stemmed: it is confessedly a better delineation than the former one, due partly to more distinct preservation. The former suture-line has, however, more of the characters seen in that of *Sonn. irregularis*, Pl. XCVIII, fig. 6.

[1] This specimen of *Sonn. magnispinata* (Pl. XCVIII, figs. 1—3) was cleaned in order to see how far the spines could be preserved by careful work. It was not altogether a good subject, but the result of some very tedious labour was fairly successful; it shows that the barbarous method of cleaning these fossils with a chisel is to be entirely condemned. Lately I obtained at Bradford Abbas a fairly large spinous *Sonninia*, presumably *crassiformis*, which parted from the stone, leaving the tops of all its spines in the block. It was necessary, therefore, to extract each of these spines and wrap them in paper. When the specimen came home more than twenty of these spines were successfully fitted and fixed with glue. The specimen promises to be very fine when finished, but the clearing of the matrix has not yet been attempted.

Of course, to induce them to undertake tedious work such as this, and the still more laborious task of cutting away the matrix in small pieces—processes involving an immense outlay of time,—the working collectors would need to be assured of selling their fossils at very greatly enhanced prices. In this matter, however, except in a few cases, their experience has been unfortunate—the extra time and labour have not proved remunerative, and it was necessary for them to adopt the shortest method of work, and this proved bad for the spines.

SONNINIA BREVISPINATA, *S. Buckman*. See Plate LXXV, figs. 6—8, and page 343.

This species was supposed to be connected with *magnispinata* by means of *semispinata* ; but the latter has different septation, and has now been removed.

2. Ribs fairly upright.

SONNINIA MUTANS, *S. Buckman*. Plate XCI, figs. 4—6.

Discoidal, compressed, hollow-carinate. Whorls ornamented with regular spines to about 13 mm. shell-radius, with spinicostæ and costæ 2 to 1, later 1 to 4, to about 47 mm. radius; with bullicostæ to about 70 mm. radius; lastly, with direct, not prominent, not distant, nearly upright, ventrally-inclined costæ. Ventral area rounded, the median part slightly depressed, divided by a small, well-defined, rounded, slightly impressed hollow-carina. Inner margin slightly defined until the bullicostate stage; later more defined, slightly convex, nearly upright. Inclusion about two-fifths. Umbilicus open, concentric, with gibbous, spinous whorls. Whorl-section quadrate-oblong. Suture-line with asymmetrical *L*, its terminal lobule anisosceloid, intra-axial, its lateral lobules nearly isometric, non-partite, not opposite.

By its external form and ornamentation this species would seem to be the link between *spinosa* and *quadrifida* (p. 394); but its suture-line, showing an asymmetrical lobe with intra-axial and isosceloid terminal lobule, indicates considerable difference. These characters of the suture-line are like those of the *paucinodata*-group (pp. 370 and 408), but the *L* is narrower stemmed; further, the ornament does not allow it to be placed in this connection—the spines are too numerous and too strong for a descendant of *nodata*. It is in these characters that it differs specifically from that species, and it shows, further, more upright ribs, more quadrate whorls, and a well-defined inner margin.

The characters of ornament and suture-line show the greatest affinity, in a genetic sense, with *Sonn. magnispinata* (pp. 341 and 413), but it cannot be placed as a descendant of that species because its ribs are far less reclinate throughout life. Its present position, then, as a collateral of *magnispinata*, but a step later in development, seems the only one possible.

Sonninia mutans occurs in the *Concavum*-zone at Bradford Abbas.

SONNINIA SUBCOSTATA, *S. Buckman.* Plate CIII, fig. 6.
See Plate LXXI, figs. 4, 5, and page 330.

Add to description :—Suture-line with asymmetrical superior lateral lobe, the terminal lobule intra-axial, anisosceloid; the lateral lobules nearly isometric, non-partite, not opposite.

The removal of this species from the *submarginata*-stock (p. 328) is necessary on account of the details of its suture-line. This agrees most nearly with that of *Sonn. mutans*, but in external characters the two species are so dissimilar that direct genetic connection between them is unlikely.

β. Lateral lobules short.

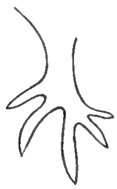


FIG. 44.—Outline of *L* of *Sonn. plicata.*

SONNINIA PLICATA, *S. Buckman.* Plate XCVII, figs. 6—8.

Discoidal, compressed, hollow-carinate. Whorls ornamented with irregular-sized, direct, reclining bullicostæ and costæ, inclined but obscure ventrally. (A regular spinous stage lasts to about 14 mm. shell-radius, then spinicostæ and some costæ to about 22 mm.;[1] then costæ and subspinicostæ, first as 3 to 1, later as 2 to 1—the rib following the bullicosta generally more prominent than the other in both cases,—later irregular, to about 60 mm.; then alternate large and small costæ; later costæ more of a size, but somewhat unequally distant.) Ventral area rounded, divided by a small hollow carina; the core with small rudimentary sulci. Inner margin fairly defined in the costate stage, and steeply sloped. Inclusion about two-fifths. Umbilicus open, the central whorls ornamented with the somewhat closely-set spines of the regular-spined period, the outer whorls with the ribs and sub-spines passing to bullæ of the irregular-

[1] These stages are obscurely shown on the other side of the figured specimen.

spined period. Whorl-section elliptical. Suture-line with rather long, thin-stemmed lobes, not strongly branched; *L* carrying on its inside several minor lobules, the inner lateral lobule being small; terminal lobule intra-axial, anisosceloid; lateral lobules anisometric, short.

The paired ribs are similar to what obtains in *S. biplicata* and *S. alternata;* but from both of these the present species is distinguished by its septation. Further, it is less gibbous-whorled, less ornate, and less spinous than the first; more umbilicate and differently costate to the second.

Sonn. plicata is a rare fossil in the *Concavum*-zone of Bradford Abbas. It is figured in Pl. XCVII: fig. 6, side view, and fig. 7, front view, both reduced to two-thirds natural size; fig. 8, the septa.

Sonninia semispinata, *S. Buckman.* Plate CIII, fig. 15.
See Plate LXXVII, figs. 1, 2, and page 343.

Add to description:—Septa with fairly long but brevilobulate lobes, *L* with terminal lobule intra-axial, anisosceloid; lateral lobules short, inner lateral lobule much abbreviated and rudimentary, outer lobule slightly bipartite.

The septa prevent this species being included in the *magnispinata*-stock, which the external features seem to warrant (p. 341); and they cause its association with *Sonn. plicata.* They do not quite agree with the suture-line of that species, but they show considerable similarity. External features show little likeness to *plicata;* there is hardly that similarity even which might suggest genetic connection between the two forms.

γ. Lateral lobules rather long, outer bipartite.

Fig. 45.—Outline of *L* of *Sonn. revirescens.*

SONNINIA REVIRESCENS, *S. Buckman.* Plate C, fig. 9.
See Plate LXX, fig. 1, and page 324.

Add to the description :—The costæ which follow the spinous stage are grouped somewhat irregularly and obscurely in pairs. Septa with fairly long lobes, *L* with terminal lobule intra-axial, anisosceloid, inequicellate; lateral lobules not very anisometric, not opposite.

δ. Outer lateral lobule of *L* strongly bipartite.

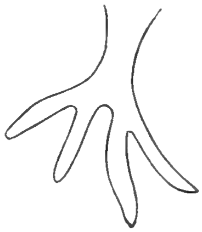


FIG. 46.—Outline of *L* of *Sonn. biplicata.*

SONNINIA IRREGULARIS, *S. Buckman.* Plate XCVIII, fig. 6.
See Plate LXI, and page 320.

To the description add :—Suture-line with somewhat asymmetrical *L*, the terminal lobule intra-axial, anisosceloid, inequicellate; the lateral lobules anisometric, the outer the larger and bipartite.

A fine specimen has been figured in Pl. LXI, and this is the type of the species. It will be advisable not to trust the part of the description referring to forms supposed to be its varieties. It is only too probable, from what has been shown in other cases, that this supposition may not be supported by the septation.

SONNINIA BIPLICATA, *S. Buckman.* Plate CIII, fig. 16.
See Plate LXXVIII, and page 345.

The type of this species is the specimen depicted in Pl. LXXVIII, figs. 1—3. The example described as *Sonn. biplicata* β differs in ornamentation; and its suture-line, which has now been obtained (Pl. CIII, fig. 16), differs in lacking the strong bipartition of the outer lateral lobule of *L*. It is doubtful whether under these circumstances it can remain in the present species.

The type agrees with *Sonn. irregularis* in septation, but the pronounced pairing and connation of its strongly reclinate costæ prevent the species being regarded as directly connected genetically. *Sonn. irregularis* gives signs of having produced a form with rather upright single ribs.

B. The lobes become short in catagenesis.

FIG. 47.—Outline of *L* of *Sonn. ptycta*.

a. Costæ weak.

SONNINIA SPINIFERA, *S. Buckman.* Plate C, figs. 1—4.
See Plate L, figs. 14, 15; Plate LXXIV, figs. 4—6,[1] and page 335.

The description of the young and immature shells has been already given. The adult shell has since been identified, and it has another whorl, which shows rather broad, inconspicuous, direct ribs, practically obsolete on the outer third. The ribs are very feebly bullate in their middles, rather variable in size and slope, tending to become more upright, and much more distant with age; in fact, there are only about half as many ribs on the last half-whorl as on the last half of the preceding whorl, and, in proportion to the size of the shell, they are less conspicuous. The ventral area is rounded; the carina is small. The inner margin becomes more defined with age and slightly subconvex. The suture-line is somewhat simple; the superior lateral lobe is asymmetrical, owing to the anisometry of the lateral lobules; the terminal lobule is intra-axial, very anisosceloid, very inequicellate.

This adult specimen, which is more than a whorl larger than the one previously figured, makes an important contribution to our knowledge of the species. It is seen that there is a tendency towards less costation with age, the ribs produced are fewer in number, for in places they are wanting, somewhat irregular, and in

[1] An uncorrected error gives "*spinigera*" in the explanation of Plate LXXIV. This should be altered.

proportion to size less conspicuous, if anything. The development of the suture-line is noticeable. In Pl. LXXIV, fig. 6, it is shown that the suture-line of the young shell has an asymmetrical *L* due to anisometry of the lateral lobules. In the larger specimen—the suture-line taken three-quarters of a whorl later than in the smaller one—the anisometry of the lateral lobules is still more marked. In another suture-line from the same fossil, taken a whorl later, the anisometry of the lateral lobules of *L* is very pronounced; the inner lobule is very much abbreviated, and may be considered as aborted.

Sonn. spinifera was placed in connection with the *acanthodes*-stock (p. 335), and the anisometry of the lateral lobules of *L* is similar to what obtains in *Sonn. ptycta* and *Sonn. cymatera.* The septation is, in fact, very like that of the latter, but the external ornamentation is very unlike. There is no need now to remark on the difference between the adults of these shells—they are obvious from the figures in Pl. C; but the young shells are more alike, and some pains were taken to show the differences (p. 336).

One mistake was made—the ribs of the young *spinifera* were said to be "more reclining" than those of *cymatera.* This is hardly correct. The ribs of the young *spinifera* are somewhat variable in slope, but tend on the whole to become rather more upright with age; those of *cymatera* become rather more reclinate. It is in the earlier whorls of the young shell that *spinifera* shows more reclinate ribs than *cymatera;* later on the balance is rather the other way. The adult *spinifera* now figured shows practically upright ribs on the last whorl, and is in marked contrast to the adult *cymatera.*

β. Costæ strong.

Sonninia acanthodes, *S. Buckman.* Plate C, fig. 8.

See Plates LVIII, LIX, LX, and Plate LXIII, fig. 1, and page 319.

Add to description: suture-line with long lobes, *L* with intra-axial, anisosceloid, inequicellate terminal lobule; lateral lobules somewhat anisometric, but both fairly developed.

Portions of the outlines of two septa of the type are shown in Pl. C, fig. 8.

Sonninia ptycta, *S. Buckman.* Plate XCVI, fig. 7.
See Plate LXXIII, fig. 1, and page 332.

Add to description: suture-line with *L* asymmetrical—the terminal lobule very anisosceloid, intra-axial, and inequicellate; the lateral lobules very anisometric, the inner lobule being very much abbreviated.

Compared with the suture-line of *acanthodes* the lobes are altogether shortened, *L* has become more asymmetrical, and its inner lateral lobule is very considerably abbreviated. The septal outlines of *S. ptycta* have been placed on the same plate with those of its morphic equivalents, *Sonn. marginata* and *Sonn. regularis.* The differences between them are noticeable, and attention is drawn to them in the explanation of the plate.

Sonninia cymatera, *S. Buckman.* Plate C, figs. 5—7.
See Plate LXXIII, figs. 2, 3, and page 332.

In the description (page 332), for "somewhat reclining" read "strongly reclining;" the former is certainly an oversight.

Add to description: suture-line with short lobes; *L* with very intra-axial, anisosceloid terminal lobule; lateral lobules anisometric.

Compared with the suture-line of *ptycta* (Pl. XCVI, fig. 7), there seems to be a general shortening in the lobes of *cymatera*, and even a shortening in the outer lobule of *L*. The lobes figured in Pl. C, fig. 7, are those of an adult example, shown of reduced size in fig. 5. The suture-line of the young type could not be made to show with sufficient clearness for tracing, but enough detail was observed to indicate its agreement with that of the specimen figured in Pl. C. This specimen agrees with it in ornament and proportion: it shows the persistence of strong ribs in maturity, and their reclination seems to increase.

C. The lobe remains long, but *L* becomes very asymmetrical.

a. Inner lobule of *L* much abbreviated in spinous species.

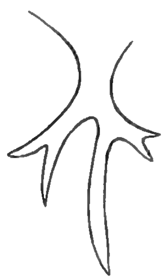


Fig. 48.—Outline of *L* of *Sonn. gibbera.*

Fig. 49.—Outline of *L* of *Sonn. modesta.*

1. Costæ regular.

SONNINIA RECLINANS, *S. Buckman.* Plate XCVIII, fig. 7; Plate CIII, fig. 21.

1892. SONNINIA CRASSISPINATA (*pars*). This Monograph, Plate XLVIII, figs. 16, 17; Plate LXV, figs. 3, 4,[1] and p. 318 (*pars*).

As the type of this species I take the form figured in Pl. XLVIII, figs. 16, 17, of which part of the septal margin is shown in Pl. XCVIII, fig. 7. This was one of the forms alluded to as *crassispinata* α in p. 318, and the differences between it and *crassispinata* β were pointed out. Practically these consisted of a greater duration of the irregular spinous stage in what is now *reclinans;* and to this has to be added difference in septation, *L* with more intra-axial, anisosceloid terminal lobule.

As *crassispinata* α there was also reckoned (p. 318) what is now, on the evidence of its suture-line coupled with its ornament, presumed to be the young of *Sonn. locuples* (p. 431). That form differs from *crassispinata* β in the same way as what is now *reclinans*, namely, in having a long and marked irregular spinous stage; but it differs from *reclinans* in septation, *L* has a less anisosceloid, more axial terminal lobule, and in having the non-spiniferous costæ stronger. Although the latter difference is not very marked in the young fossil compared to *reclinans*, and the drawings in the plates may give a somewhat false idea, yet the difference between *reclinans* and adult *locuples* in this respect is particularly noticeable.

With *reclinans*, and under the same name, what was described as *crassispinata* γ (p. 318), may now be associated as a variety. It was noticed at the time as a descendant of *crassispinata* α, and not of β. From type *reclinans* it differs in being more quickly coiled and more compressed, its flatter-sided whorls being particularly noticeable. Its septa are shown in Pl. CIII, fig. 21: they agree with the suture-line of the type *reclinans* (Pl. XCVIII, fig. 7), except in the greater breadth of the siphonal saddle—a feature certain to be associated with flatter whorls.

SONNINIA GIBBERA, *S. Buckman.* Plate LXXXVII, figs. 4, 5; Plate LXXXVIII, figs. 1—3.

Discoidal, compressed, hollow-carinate. Whorls ornamented with small, direct, reclined, ventrally-inclined costæ and spinicostæ about as 2 or 3 to 1 on the inner side of the spine. The spinicostæ are larger than the costæ, and are somewhat strongly spined; beyond the spine they are often obscurely bifurcate. Ventral

[1] It is requested that the explanation of the plates be altered in accordance.

area rounded, divided by a fair-sized hollow carina. Inner margin ill-defined, nearly upright. Inclusion about one-third, but not up to the spines except in the central whorls. Umbilicus with a regular spinous stage in the central whorls,[1] very soon yielding to an irregular spinous stage. Whorl-section gibbous-sided, oval. Suture-line[2] with rather long, narrow-stemmed lobes: the terminal lobule of *L* intra-axial, anisosceloid, inequicellate; the lateral lobules, which are at first isometric, and not opposite, become with age very anisometric, the inner lobule being practically aborted.

In septation this form agrees, when young, with *Sonn. reclinans*, and it is not difficult to imagine it a descendant thereof; it is in part distinguished by being more quickly coiled, broader whorled, and more coarsely ornamented,—all these might be features of development. It also has resemblance to *Sonn. acanthodes* and *Sonn. irregularis*, but it is more quickly coiled and less spinous than the first, has more gibbous sides, few and smaller spines, and different septation from the second.

A remarkable feature which this form exhibits is the abortion of the inner lateral lobule of *L*, shown by the septa of the same specimen at different ages.

Sonn. gibbera occurs in the *Concavum*-zone of Bradford Abbas. The type-specimen is figured in Pl. LXXXVII: fig. 4 side view, fig. 5 front view reduced to two-thirds of natural size. In Pl. LXXXVIII, fig. 1 gives the septa from another specimen, and figs. 2 and 3 part of the suture-lines from yet another example.

SONNINIA MODESTA, *S. Buckman*. Plate XCV, figs. 3—5; Plate XCVI, figs. 1, 2. See Plate LXX, fig. 5, and page 325; also ? abnormal form, Plate LXVIII, and its septa, Plate CIII, fig. 5.

It has been considered advisable to figure the actual type of this species when it was found that there was a considerable difference in septation between it and the presumably abnormal form (Pl. LXVIII). The septa of the type have been drawn again, more matrix having successfully been removed, and they show much complexity, *L* having a terminal lobule very intra-axial, very anisosceloid and inequicellate, and the lateral lobules very anisometric, the outer lobule being strongly bipartite, almost tripartite. The species just described seemed to indicate that such features as these would be the outcome of their phyletic development.

[1] Detail from another specimen.

[2] From other examples.

The abnormal form has septa which are similar, but they are much less elaborate in outline, and lack the bipartition of the outer lobule; in fact, the lobe-line appears to have undergone degeneration, though of course it may never have attained to the elaboration of type *modesta.* More evidence is required on this head before it can be decided whether the forms are properly united under one name. Barring the coarse ribs of the "abnormal" form, the only external difference is its greater smoothness.

Of the form alluded to as *modesta* β (p. 326), an example sufficiently satisfactory to give a good figure with its septation has not yet been worked out.

In Pl. XCV, fig. 3 shows the side view of the type of this species reduced to one-half natural size, fig 4 the front view in outline similarly reduced, and fig. 5 the suture-line. A young typical specimen illustrating the spinous stage followed by the subcostate stage is depicted in Pl. XCVI, fig. 1, view of part of its periphery fig. 2, both these figures being of natural size.

Sonninia simplex, *S. Buckman.* Plate CIII, fig. 11.
See Plate LXX, figs. 2, 3 (not 4), and page 326.

For the description given of the suture-line substitute the following: suture-line somewhat degenerate, denticulation being weak, *L* markedly asymmetrical, the terminal lobule very intra-axial, anisosceloid, inequicellate, the lateral lobules markedly anisometric, the inner aborted, the outer tripartite.

From *gibbera* to *simplex* is a very long jump, but the septa of the type which have now been worked out suggest this association; there is the same abortion of the inner lateral lobule of *L*, and even a similarly curved terminal lobule. In outline the septa would appear to have undergone phylogenetic degeneration, for the denticulations are not sharply and deeply cut—compared with those of *modesta* (Pl. XCV, fig. 5) there is a marked contrast; but there is a certain similarity to those of the "abnormal" *modesta.* The latter, however, has a more developed inner lobule of *L*, and a less markedly bipartite outer lobule. The interposition of *modesta* between *gibbera* and *simplex* lessens the gap between these forms, but it seems to make the decline in the septation of *simplex* all the more marked.

In Pl. LXX, fig. 4 shows a suture-line taken from a specimen externally similar to the type *simplex.* Yet its suture-line differs because it shows *L* without an aborted inner lobule. It would, therefore, seem that similar as this specimen is, it has been the offspring of another genetic series, which did not abbreviate the inner lobule in catagenesis (see the *subirregularis*-series, *Sonn. subsimplex,* p. 427).

2. Costæ paired.

Sonninia alternata, *S. Buckman*. Plate CIII, fig. 7.
See Plate LXXVI, figs. 7—9, Plate LXXVII, figs. 3—5, and page 346.

Add to the description: suture-line with fairly long lobes, *L* with very anisosceloid, inequicellate, intra-axial terminal lobule; lateral lobules very anisometric, inner lobule much abbreviated, outer lobule feebly bipartite.

Sonn. alternata is distinguished from *Sonn. revirescens* by greater asymmetry of *L*, and by much stronger costæ following the spinous stage.

In spite of external resemblance to *S. biplicata* in the matter of paired ribs, an association with *biplicata* α is rendered doubtful by the septal details. Considering that the course of septal development, consequent on the flattening of the area supported by the outer lobule of *L*, is to make the support larger, it would be difficult to imagine an abbreviation of the strongly duplicate outer lobule of *L* in *biplicata* sufficient not only to reduce it to the proportions of the outer lobule of *L* in *alternata*, but to cause the duplication almost to disappear. The tendency of the development is to enlarge the outer lobule at the expense of the inner, whereby the duplication should become stronger, and the reason for the abbreviation of the inner lobule in course of development is seen in the greater approximation of septa which accompanies catagenesis.

In *Sonn. biplicata* β, Pl. CIII, fig. 16, the septa are more of the pattern seen in *alternata;* but it may reasonably be doubted whether the association of *biplicata* α and β in the same species is justifiable. Doubt is thrown on the possibility of *biplicata* β having developed into *alternata* α, by the difference in the ventral inclination of the ribbing, it is so much greater in the former.

β. Inner lateral lobule of *L* not abbreviated in spinous species (but it is so later on in the phyletic series[1]).

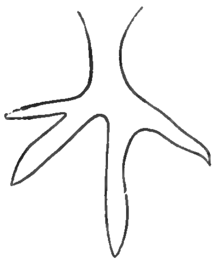


Fig. 50.—Outline of *L* of *Sonn. subirregularis*.

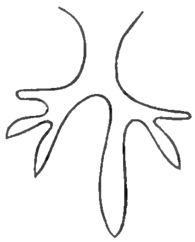


Fig. 51.—Outline of *L* of *Sonn. subsimplex*.

[1] Abbreviation of the inner lateral lobule of *L* begins much later in this series than in that arranged under *C*, α; and consequently in the smooth form (*S. subsimplex*) anisometry of the lateral lobules is less marked than in the spinous form of the other series.

Sonninia multispinata, *S. Buckman.* Plate CIII, fig. 3.
See Plate L, figs. 11—13, and page 317.

So far as external ornaments and proportion are concerned, this is, biologically, the earliest form of the *Concavum*-zone *Sonniniæ.* Its septa, however, are abnormal. One side (*a*) has the outer interlobular cell of *L* shallower than the inner one, a character of the biologically lower *Zucheria* (see Pl. CIII, figs. 1, 2), the other side (*b*) has the outer interlobular cell deeper than the inner.[1] In the former case the terminal lobule is ultra-axial, in the latter intra-axial. In both cases it is anisosceloid, but on side *a* it is ecto-brachysceles, on side *b* it is endo-brachysceles.

The septal details do not give any authority for the present position of the species. It might be placed at the head of many of the other stocks. This seems, however, the most convenient place.

Sonninia crassispinata, *S. Buckman.* Plate XCIII, fig. 7.

1892. Sonninia crassispinata. This Monograph, Plates lvii, lxv, fig. 5 only (not Plate xlviii, figs. 16, 17, Plate lxv, figs. 3, 4, see *Sonn. reclinans;* not Plate l, figs. 16—22, see *Sonn. locuples* [2]), p. 317.

At p. 318 *Sonn. crassispinata* was divided into three varieties, α, β, γ; and it was pointed out that they differed in external ornament and in proportion. It has since been found that α and γ differ from the type in septation, that one of them is the young of a form which is very different from *crassispinata* when adult, and that it is advisable to remove the other (see p. 421). As *Sonn. crassispinata* there remains, then, the form called β, and it is illustrated in Pl. LVII; its whorl-section Pl. LXV, fig. 5. Its septa have been redrawn in Pl. XCIII, fig. 7, for comparison with the septa of *Sonn. locuples.* It will be seen that the terminal lobule of *L* is intra-axial and inequicellate, though practically isosceloid.

[1] The letters *a* and *b* have been inadvertently omitted in the printing of the plate. The right-hand side of the keel-line in fig. 3 of Plate CIII should be marked *a*, the left hand *b*.

[2] It is requested that the explanation of the plates be altered in accordance.

Sonninia subirregularis, *S. Buckman.* Plate XCVIII, figs. 4, 5; and young form, Plate LXXVII, figs. 6—9, Plate LXXXVIII, fig. 4.

Discoidal, compressed, hollow-carinate. Whorls ornamented with regular spines up to about 47 mm. diameter of shell, with costæ and spinicostæ as 2 to 2, roughly in pairs, to 85 mm. diameter, and as 3 to 1 to 130 mm. diameter; lastly, with regular, fairly well-marked, close, direct, somewhat reclining, ventrally-inclined costæ. Ventral area rounded, divided by a well-defined, not large hollow-carina. Inner margin well defined, subconvex, nearly upright. Inclusion one-fourth, not up to spines after 43 mm. diameter. Umbilicus graduate, spinous in middle. Whorl-section oblongo-quadrate. Suture-line with fairly ornate lobes; *L* with intra-axial, anisosceloid, inequicellate terminal lobule; anisometric lateral lobules, the outer bipartite.

In ornament and proportions this species stands between *Sonn. irregularis* and *Sonn. marginata;* but it is less coarsely ornamented, and costate more regularly and at a much earlier age than the first; while it is more spinous, and spinous for a much longer time than the second. Except for its septation this species might seem to connect these forms; but it has a more ornate suture-line than *irregularis,* and a considerably more florid septation than *marginata.* The suture-line agrees with that of *S. crassispinata*, the outer lobule of *L* being slightly more bipartite. From *S. acanthodes* the more upright ribs are an easily noted feature of distinction.

The small specimen illustrated in Pl. LXXVII, figs. 6, 7, is presumably the young of this form. The only noticeable difference is a slightly more abbreviated inner lateral lobule of *L* (Pl. LXXXVIII, fig. 4) than the young of *S. subirregularis* would be expected to possess.[1] The younger specimens (Pl. LXXVII, figs. 8, 9) may be classed with this one.

Sonn. subirregularis occurs in the *Concavum*-zone of Bradford Abbas. The type-form is illustrated in Pl. XCVIII: fig. 4, the side view, a copy from a photograph, much reduced; fig. 5, the suture-line. The dimensions of the type are—radius 162 mm., umbilicus 114 mm., umbilicus, one whorl back, 49 mm., two whorls back, 22 mm., three whorls back, 9·5 mm. Breadth of whorl, from inner-marginal suture to carina, 93 mm. Thickness of whorl, about the middle, 62 mm., over costæ, 68 mm., at top of inner margin, 57 mm., all without test.

[1] In the specific identification of young specimens the smallest differences should be noticed with rigid exactness; by the time these specimens had become adult small initial differences might have grown so pronounced as to entirely alter the appearance of the shell.

SONNINIA SUBSIMPLEX, *S. Buckman.* Plate XCV, figs. 6—8; and variety (?), Plate CIII, fig. 19, suture-line.

1892. SONNINIA SUBSIMPLEX. This Monograph, p. 328.

Discoidal, compressed, subcarinate. Whorls nearly smooth, showing only some small, closely-set, obscure, direct costæ, which are coarser, more distant, and often liable to local failure, and never very prominent in adult. Ventral area subacutely arched, subcarinate—the carina very small and ill-defined; after about 160 mm. diameter, flattened, and the carina a little more marked, subimpressed. Inner margin fairly defined, steeply sloped, barely subconvex. Inclusion about one-quarter. Umbilicus markedly excentric. Whorl-section oblong. Suture-line with a very intra-axial, anisosceloid, terminal lobule to *L;* the lateral lobules of *L* anisometric, the outer tripartite, the inner slightly bipartite; the inferior lateral lobe similar to *L,* but its terminal lobule even more intra-axial, the two principal lateral lobules well developed.

The above description does not quite apply to the young form; that is slightly more carinate and more involute: at a diameter of about 135 mm., when the excentricity of the umbilicus first begins to be noticeable, the inclusion is nearly one-half.

The septal margin shown in Pl. CIII, fig. 19, belongs to what may be a mutation of *S. subsimplex.* In proportion the shell is similar, though its umbilicus is more excentric on account of less umbilicate central whorls; the test is smoother, the septa are decidedly more ornate, and different in many respects from those of *Sonn. subsimplex*—for instance, the siphonal saddle is more occupied by lobes, the terminal lobule of *L* is more anisosceloid, and *L* is more symmetrical. The chief interest that attaches to this specimen is that it is, in side view, practically indistinguishable from *Sonn. simplex;* in front view it is a mere trifle thinner, but in septation (compare figs. 19 and 11 of Pl. CIII) there is a most astonishing and remarkable difference.

Sonn. subsimplex (type) is similar to *modesta*, but thinner; the ventral area is more fastigate; the carina is smaller and less defined; the ornamentation is similar, but the ribs are less conspicuous; the umbilicus is more excentric, the suture-line is shorter in its lobes, and the saddles are less occupied; the inner lobule of *L* is much less abbreviated; the terminal lobule is more intra-axial. From *Sonn. simplex* this species differs by being carinate throughout life, by its umbilicus being more concentric, especially in the early whorls, by not being so smooth, and by having more florid septa.

From *Sonn. inæqua* it differs by being less costate, less carinate, and less umbilicate, though the umbilicus is more excentric.

In septation this species seems to conform to what would be expected of the development of *S. subirregularis;* in external appearance it gives very little guide to its genealogy.

Sonn. subsimplex occurs in the *Concavum*-zone of Bradford Abbas, and cannot be called a rare species. It is figured in Pl. XCV: fig. 6, side view; fig. 7, outline front view, both reduced one-half; fig. 8, septa.

D.[1] The lobes are decidedly long, and there is little degeneration of lobes or lobules in phyletic development.

A. The lobes are fairly developed.

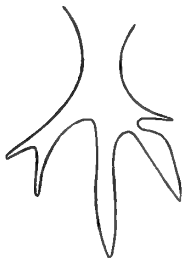


FIG. 52.—Outline of *L* of *Sonn. costigera.*

FIG. 53.—Outline of *L* of *Sonn. obtusiformis.*

SONNINIA COSTIGERA, *S. Buckman.* Plate CII, figs. 1—3.

Discoidal, compressed, carinate. Whorls ornamented after the regular spinous stage,[2] with costæ and nodicostæ—as 3 to 1—to about 60 mm. diameter, later with numerous, direct, reclining, closely-set, rather small, often connate costæ; later with larger, more distant, undulate, very feebly bullate, direct, somewhat reclinate, separate costæ. Ventral area rounded, somewhat flattened medianly, divided by a small, rounded hollow carina. Inner margin steep, ill-defined. Inclusion not two-fifths. Umbilicus concentric, graduate, with slightly gibbous whorls. Whorl-section somewhat obovate. Suture-line with a somewhat long, symmetrical superior lateral lobe, the terminal lobule axial, but slightly anisosceloid and inequicellate; the lateral lobules nearly isometric, not quite opposite.

[1] The stocks included in this division seem also to be characterised by a tendency to enlarge their costæ after a period of decline, even so much as to become spinous.

[2] This stage lasted apparently to about 35 mm. diameter, but the centre is badly preserved, and has been damaged by the tool.

More gibbous-sided whorls, a more concentric umbilicus, a slower manner of coiling, a less definite inner margin, and smaller, closer set costæ in the early costate stage distinguish this form from *Sonn. marginata.* The characters of the margin, the coiling, and the costæ separate it from *Sonn. regularis;* and, further, the septation distinguishes it from either of these species. Less reclinate costæ and a nearly symmetrical superior lateral lobe mark it as different from *Sonn. ptycta* or *Sonn. cymatera.*

The species to which *Sonn. costigera* has the most resemblance is really *Sonn. obtusiformis*, although the much stronger ribbing appearing at an earlier age in that fossil is a noticeable feature of contrast. However, the mode of coiling is the same, and the enlargement of the ephebic ribs is similar though not so pronounced. The suture-line is also similar to a certain degree—there is a resemblance in the bipartition of the inner lobule of the superior lateral lobe; while the points of difference—the intra-axial position of the terminal lobule, and the bipartition of the outer lobule in *Sonn. obtusiformis*—may be features correlated with the further development which the costæ indicate. The figured specimen of *Sonn. costigera* was alluded to in p. 333 as probably intermediate between *Sonn. ptycta* and *Sonn. cymatera;* but the subsequent removal of matrix, and after much labour the exposure of part of the suture-line, indicates that this idea cannot be sustained. Yet its association with *obtusiformis* alluded to in the same page—it is spoken of as indicating the connection of *ptycta* and *obtusiformis*—is apparently correct, as may be inferred from my remarks above. It is necessary, then, to remove *costigera* and *obtusiformis* from association with the *acanthodes*-stock; for they do not show that peculiar abbreviation of the inner lateral lobule of the superior lateral lobe which is seen to such perfection in *Sonn. cymatera*—especially in the adult, Plate C, fig. 6,—nor such reclinate ribbing. Then it becomes desirable to know whence *Sonn. costigera* may have sprung; and the only species which can be suggested at present is *Sonn. locuples* (see later, p. 431). In that species, however, there is a strongly-lobed suture-line with very lobulate lobes. The lobation and the lobulation are much less pronounced in *Sonn. costigera*, and still less so in *Sonn. obtusiformis;* but decline in such respects might certainly have accompanied increase in costation—a much corrugated test would of itself be stronger than one which was plainer, and it would therefore need less support. Septal degeneration, then, cannot be regarded as a difficulty; but the intra-axial position of the terminal lobule of *L* in *Sonn. locuples*, and its axial position in *Sonn. costigera* may be. It is an allowable surmise that the ancestor of *Sonn. costigera* was similar to *Sonn. locuples*, but possessed of an axial terminal lobule to *L*, and possibly of less ramified septa. On these grounds the present position of *costigera* and *obtusiformis*, near the *locuples*-group, is fairly well supported, although considered by itself alone the very slight intra-axial position of the

terminal lobule of *L* might have favoured the placing of *costigera* in one of the earlier groups.

Sonn. costigera is a scarce fossil in the *Concavum*-zone of Bradford Abbas. It is represented in Pl. CII: fig. 1, side view, reduced to three-fourths of natural size; fig. 2, front view, similarly reduced; and part of the suture-line, fig. 3.

SONNINIA OBTUSIFORMIS, *S. Buckman*. Plate XC, fig. 10 (Plate LXXXV, figs. 7, 8 ?). See Plate LXXII, figs. 3—5, and page 333.

What is presumably a young form of this species has been placed in Pl. LXXXV, figs. 7, 8. The suture-line of the type has been re-drawn in Pl. XC, fig. 10, for comparison with that of *Sonn. palmata* (see p. 374). It may be reasonable to derive the pentadactyloid *L* of this species from the tridactyloid, incipiently tetradactyloid *L* of *costigera*—there is similar furcation in the inner lobule of *L* of both species. To this end it must be supposed that the terminal lobule of the *costigera*-development became more intra-axial and more anisosceloid.

B. The lobes are remarkably developed, and the septa are much interlocked.

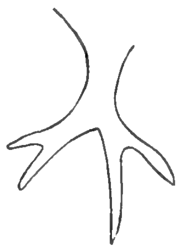


FIG. 54.—Outline of *L* of *Sonn. renovata.*

The above heading applies to a group of species which are remarkable for their very long, closely interlocked lobes. By their septation they are distinguished from other species of similar external form, which mostly possess rather short lobes. This is strikingly illustrated by the figures in Pl. XCIV, which show two species very similar in shape, possessed of remarkably different septa.

The following fossils fall into at least two series; to understand them it is necessary to draw attention to the biologically-earliest species, *Sonn. locuples*. Under this name are grouped for the present two forms which show only slight external differences from one another: *Sonn. locuples* β is coiled fractionally closer to the spines than is the type, *Sonn. locuples* α. In septation there is one

difference—in *Sonn locuples* β the outer lobule of *L* is strongly bipartite, in *Sonn. locuples* α the outer lobule is practically entire. The strong bipartition of the outer lobule of *locuples* β is seen to be a feature in another species, *Sonn. dominans*. In the young *Sonn. renovata*, however, the bipartition is only incipient—about as much as in *locuples* α, and not in the same place as *Sonn. locuples* β, —though in adult *renovata* this bipartition is somewhat stronger; while in *Sonn. reformata* the outer lobule is distinctly not partite. In *Sonn. loculosa*, on the other hand, the bipartition is strongly marked, and it is in the same place as in *locuples* β and *dominans;* but the outer lobule is altogether shorter than in *dominans*, so that the agreement is not quite exact.

Considered, however, in this manner, the species may be arranged in two series at present, with starting-points in the two forms of *locuples;* and they may be distinguished thus:

Sonn. locuples.—Evolute, spinous to bullicostate.
Two varieties:—α, the outer lobule of *L* not partite.
β, the outer lobule strongly bipartite.

From α, the outer lobule not partite,—
Sonn. renovata.—Spinous to costate to renewed bullicostate and spinous stages.
Sonn. reformata.—Spinous to costate.

From β, outer lobule strongly bipartite,—
Sonn. dominans.—Involute, costate.
Sonn. loculosa.—Involute, subcostate.

More particular remarks on the affinities of these species will be found in the following specific articles.

SONNINIA LOCUPLES, *S. Buckman.* Plate XCII, figs. 1—4, Plate CIII, fig. 4.

1892. SONNINIA CRASSISPINATA, *S. Buckman.* This Monograph, Plate L, figs. 16—18 only (and figs. 19—22 ?).[1]

Discoidal, compressed, hollow-carinate. Whorls ornamented with costæ and irregularly-placed spines—the costæ direct and somewhat reclining,—later with bullicostæ, later still with plain, not too conspicuous costæ. Ventral area rounded in adult, somewhat flattened, divided by a not very prominent, rounded hollow carina. Inner margin fairly conspicuous, nearly upright. Inclusion about one-third, but not up to the spines except in very early life. Umbilicus open, ornamented with fairly-marked ribs, and not very prominent tubercles. Whorl-

[1] It is requested that the explanation of the plate be altered in accordance.

section gibbous-sided oblong. Suture-line with extraordinarily lengthy lobes, narrow-stemmed and considerably branched; the lateral lobules of *L* so prolonged as to touch in some places the part of the preceding septum bounding the siphonal saddle, and the terminal branch of *L* penetrating the stem of its predecessor.

This species is remarkable for the great development of its lobes. The only described species of this genus which approaches it in this respect is *Sonn. crassispinata;* but in that the lobes are not so developed, and more space is left unoccupied by them. Again, at the same diameter as in this species, *L* of that species does not enter the stem of its predecessor by some 4 mm., while the lateral lobule is some 12 mm. from the preceding siphonal saddle (see Pl. XCIII, fig. 7).

In Pl. CIII, fig. 4, are given further details of the suture-line of the specimen figured in Pl. L, figs. 16 to 18, as *Sonn. crassispinata.* The septation shows that this fossil is a young specimen of *Sonn. locuples* α. It has very long lobes, which agree with the pattern of this species, but differ from those of the type *crassispinata* in having a more anisosceloid terminal lobule to *L.* Externally the form differs from that species in greater irregularity of the spinous stage, as was pointed out in p. 318.

It has been mentioned above (p. 431) that there are two varieties of *Sonn. locuples;* and the differences between them have been stated. On account of their close agreement in general details, it is assumed, until evidence to the contrary be forthcoming, that in *S. locuples* is the starting-point of two genetic series, distinguishable by a peculiarity in their septation.

Sonn. locuples is a rare form in the *Concavum*-zone of Bradford Abbas, but one easily identified if its suture-line be exposed. It should be noticed that, beginning with a regular spinous stage, the greater part of the fossil is taken up with an irregular spinous stage; then follows a short bullicostate stage; lastly, the ordinary costate stage is assumed.[1] These phases are shown by the type-specimen illustrated in Pl. XCII, figs. 1, 2, and the suture-line is shown in Pl. XCII, fig. 3. The suture-line of an immature specimen to compare with the suture-line of *crassispinata* β is given in fig. 4 of the same plate. This suture-line is taken at a somewhat smaller diameter than that of *crassispinata* β, shown in Pl. XCIII, fig. 7.

The immature stage of *Sonn. locuples* α is illustrated in Pl. L, figs. 16 to 18, by a specimen which was described as *Sonn. crassispinata,* a designation which must now be altered in view of the more complete details of its septation which removal of test has exposed: these details are given in Pl. CIII, fig. 4. Whether the young forms shown in Pl. L, figs. 19 to 22, should be reckoned here it is somewhat hazardous to say. Their real value lies in illustrating the ontogeny of spinous *Concavum*-zone *Sonniniæ.*

[1] This separates it effectually from type *crassispinata.*

a. The outer lobule of *L* non-partite or feebly bipartite.

SONNINIA RENOVATA, *S. Buckman.* Plate XCIII, figs. 1—6.

Discoidal, compressed, carinate. Whorls ornamented with ribs and spines to 35 mm. diameter, the regular tuberculate stage; then, to about 80 mm. diameter, an irregular tuberculate stage with rather small reclining ribs and small spines somewhat wide apart; later to about 125 mm., a plain costate stage, the ribs of small size, somewhat unequal and slightly reclining; then a renewed tuberculate stage, the ribs becoming larger and more distant with age, and nearly every one drawn up in the middle into an elongate knob. Ventral area arched, divided by a small presumably hollow carina. Inner margin fairly defined, steeply sloping, convex. Inclusion about one-fourth. Umbilicus tending to become more excentric in correlation with the renewed progressive stage—the inclusion being greater in youth. Whorl-section elliptical. Suture-line with long and complex lobes; *L* being slightly asymmetrical, the terminal lobule anisosceloid and intra-axial—the outer lobule in the adult being divided into two small portions more distinctly than in the young.

This is a most extraordinary species. When adult it is entirely unlike anything else that has been figured. The only species with something of the same character is *Sonn. revirescens;* but that form is not really tuberculate, and has altogether different proportions. In youth, before the noticeable secondary tuberculate stage is developed, the species is very similar to the young of *Sonn. marginata* or *Sonn. dominans*,—in fact, there is a noticeable agreement with the specimen figured in Pl. LXVII, figs. 3—5, which was regarded as intermediate between those species. In the adult stage, however, there is no similitude with either *dominans* or *marginata;* for this strong secondary tuberculate stage which makes the fossil so remarkable is not seen in either of those forms.

From the length and characters of its lobes *Sonn. renovata* would appear to be a lateral development of the *locuples*-stock, derivable from that species. The septation of young *Sonn. renovata* agrees very particularly with that of *Sonn. locuples a.* In the adult the lobes appear to undergo a certain amount of deterioration in proportion to the size of the whorl—there is a tendency to shorten, and also to spread somewhat laterally, as shown by the outer lobule.[1] These matters are of importance in connection with certain species from beds superior to the *Concavum*-zone,—species which possess an ornamentation similar to that of *renovata*, and a period of whose ontogeny seems to be explained by the various developments shown in *renovata.*

[1] The inner lobule is not well preserved.

Sonn. renovata is certainly very rare. The preservation of the adult shell suggests that it occupies a position at the very top of the *Concavum*-zone,—that is to say, it is associated with *Hyperlioceras discites*, &c.

Since the above remarks were penned, Mr. J. W. Tutcher, of Bristol, has found at Dundry a large specimen, 257 mm. in diameter. It agrees in umbilication and dimensions exactly with the type, and in ornament is almost spine for spine the same. Its septa show exactly the same asymmetry of *L*, while the terminal lobule is anisosceloid and intra-axial in the same manner as in the type; but the septa are rather closer together, and the superior lateral saddle is therefore more penetrated by lobes. The only observable external differences—and one of these is partly due to inferior preservation—are a slightly greater reclination of the costæ in some places, and a less degree of spinosity in what corresponds to the outer whorl of the type.

The specimen shows half-a-whorl more than the type, all of which is body-chamber, ornamented with somewhat reclinate bullicostæ. Mr. Tutcher very generously presented this specimen to my collection. It was sent to me as from the *Concavum*-zone, and judging by its matrix it occupies exactly the same position as the Dorset specimen, namely, the top of the beds with *Hyperlioceras*.

Sonn. renovata is figured in Pl. XCIII: fig. 1, side view of the type, reduced to two-thirds of natural size; fig. 2, the outline of the whorl-section, similarly reduced; fig. 3, septal outlines; fig. 4, a young specimen, of natural size, before the remarkable metamorphosis; fig. 5, its outline front view; fig. 6, its suture-line.

SONNINIA REFORMATA, *S. Buckman.* Plate LXXXIX, figs. 6—8.

Discoidal, compressed, hollow-carinate. Whorls ornamented with spines, subspinicostæ, and costæ: regular spines to 18 mm. diameter of shell; then plain costæ; then costæ and subspinicostæ alternate, or as 2 to 1—the spinicostæ trifurcate beyond the spine—to 45 mm. diameter; lastly, direct, somewhat numerous, somewhat irregularly-sized, reclinate, ventrally-inclined costæ. Ventral area arched, somewhat flattened, divided by a fairly-defined hollow carina, the core carinate-bisulcate, the sulci fairly-marked.[1] Inner margin ill-defined, subconvex, steep. Inclusion about two-fifths, allowing for carina. Umbilicus graduate, concentric. Whorl-section suboval. Suture-line with long and ornate lobes; *L* with

[1] The figure shows the ventral area without test—a ventral area with a distinct carina. Remains of the partition-band and of the walls of the hollow carina are on other parts of the periphery, and they indicate the size of the true carina.

a terminal lobule anisosceloid and intra-axial, the lateral lobules nearly isometric but not opposite.

The young specimen figured, which is different from anything else in my cabinet, shows in its inner whorls two spinous stages parted by a short costate stage. This feature it shares with *Sonn. scalpta*, from which its septation and its different proportions separate it. The septation shows it to be one of the long-lobed series, and the want of bipartition of the outer lobule of *L* that it is allied to *S. renovata.* That species, however, does not show two spinous stages parted by a costate stage until late in life; it has a more strongly spinous centre and more gibbous-sided whorls.

Sonn. reformata occurs in the *Concavum*-zone of Bradford Abbas. The figured specimen, which is unique, was obtained by myself from the railway-cutting. It is illustrated in Pl. LXXXIX : side view, fig. 6 ; front view, fig. 7 ; suture-line, fig. 8.

β. Outer lobule of *L* strongly bipartite.

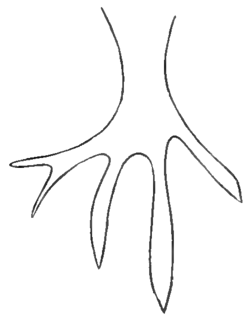


FIG. 55.—Outline of *L* of *Sonn. dominans.*

SONNINIA DOMINANS, *S. Buckman.* Plates XCIV, figs. 1, 2 ; XCV, fig. 1 ; XCVII, fig. 4.
See Pl. LXVI (only) and pages 322—324 (*pars*).

Add to the description :—Ribs of the inner whorls of the type slightly irregular in size, and obscurely connate on the inner third of the whorl. Erase description of suture-line, and substitute :—Lobes of the type-form long ; *L* with an inequicellate, anisosceloid, ecto-brachysceles terminal lobule, the lateral lobules not opposite, the outer being further back than the inner.

The above is the description of the outline of the last septum of the type-specimen shown in Pl. LXVI—the outline itself Pl. XCVII, fig. 4 ; but, although considerable trouble has been taken, the septal margin could not be cleared to

show as plainly as it should for tracing, and probably some of the minor details have suffered. The main details are probably correct, and they show, first, great length of lobe, rather abbreviated lateral lobules, possibly due to gerontic degeneration, and an ecto-brachysceles terminal lobule. The latter feature accompanying presumed septal degeneration is remarkable, because it is a return to what obtains in a biologically-earlier form, *Zurcheria.* The septal margin of an immature specimen which, as far as it goes, is nearly an exact counterpart of the type, except in being rather more costate and rather more spinous, is shown in fig. 2 of Pl. XCIV (see also outline of *L*, fig. 55, p. 435). It agrees with that of the type in remarkable length of lobe, and there is an incipient ecto-brachysceles character to the terminal lobule of *L*. It may be described as follows :—Suture-line with long and very ornate lobes, the side being almost occupied by a complete network. Siphonal lobe with bifurcate terminal branches and three lateral accessory lobules; *L* tetradactyloid because the outer lobule is double, being divided nearly to its base, the terminal lobule as long as the main stem of the lobe, intra-axial, nearly isosceloid, the inner lobule about equal in size to one branch of the outer lobule.

It is presumed that this is the true form of the suture-line before septal degeneration takes place. On this presumption the present position of the species is based. Further, the septal differences now disclosed show that under the name *Sonn. dominans* a polygenetic series of morphic equivalents had been collected. It was pointed out at the time (p. 323) that the forms could be distinguished externally, and they were grouped as varieties α, β, γ, δ. Now that these external differences are shown to be connected with distinct septal details, it has become necessary to rearrange these forms. From this association must be removed the specimen figured in Pl. LXIX,[1] as well as the forms β[2] and δ,[3] p. 323, and the immature specimen, Plate LXVII, figs. 1, 2.[4] There remains then as the type *Sonn. dominans* the specimen figured in Pl. LXII; and to this may be added, as an immature, slightly more ornate example, the specimen shown in Pl. XCIV, figs. 1 and 2, and Pl. XCV, fig. 1. Concerning other specimens described as "*dominans*" or "near *dominans*" (Pl. LXVII) see later (p. 438).

A figure of the immature *Sonn. dominans* has been placed on the same plate as that of *Sonn. dominatrix*, to facilitate comparison. It will be seen that until about the last half-whorl they are externally almost exactly alike, and in the last half-whorl of the figures there is no very great difference in ornament. At any rate, the difference was not enough to induce the suspicion of such remarkable

[1] See *Sonn. dominica* (p. 410).
[2] See *Sonn. dominata* (p. 408).
[3] See *Sonn. dominatrix* (p. 392).
[4] See *Sonninia*, sp. (p. 438).

septal unlikeness. It will, however, be seen that, besides many differences in detail, the lobes of *dominans* are about twice the length of those of *dominatrix*. Such an inequality of dimensions must point to considerable differences in the anatomical details of the soft parts of the animals in these two species.

It may be noticed that the suture-line of this species[1] has considerable resemblance to that of *Sonn. biplicata* (Pl. LXXVIII, fig. 3), which has the outer lobule strongly bipartite. In this species, however, the lobes are rather longer in proportion to the whorl, they are thinner-stemmed and more ornate. Further, the terminal lobule is anisosceloid and less intra-axial. These features do not seem to allow this species to be placed as the descendant of *biplicata*.

Young *Sonn. renovata* is not unlike this species, but it is decidedly more umbilicate, has more gibbous-sided whorls, and a different septation. Adult *renovata* is entirely different, because of its large bullicostæ.

Though it agrees in the length of its lobes with *Sonn. locuples* β, yet the immature *Sonn. dominans* shows differences of detail; for instance, the terminal lobule of *L* is isosceloid, and the stem of the lobe is wider. The bipartition of the outer lobule of *L* is similar, though very much deeper.

Sonninia loculosa, *S. Buckman*. Plate XCII, figs. 5—7.

Discoidal, compressed, hollow-carinate. Whorls ornamented with closely-set, ill-defined, not prominent, direct, slightly-reclining costæ (details of the central whorls wanting). Ventral area rounded, divided by a small hollow carina. Inner margin well-defined, broad, nearly flat, nearly upright. Inclusion about two-fifths. Umbilicus small, slightly excentric. Whorl-section oblong, very slightly gibbous laterally. Suture-line with long ornate lobes, the side being almost completely occupied; the siphonal lobe with deeply divided terminal lobule and three accessory lateral lobules, of which the middle is large and important, the other two somewhat aborted; *L* tetradactyloid on account of duplication of the outer lobule; the terminal lobule very intra-axial, isosceloid, long, being longer than the main stem, and it penetrates the stem of the preceding lobe to touch the part which connects the terminal lobule with the inner branch of the outer lobule; the inner lobule about equal in size to one branch of the outer lobule.

This species is very like *modesta* (Pl. XCV, figs. 3—5), and is in fact its morphic equivalent; the only external difference is a slightly greater thickness, most perceptible near the inner margin, owing to a slight gibbosity of the side of

[1] The immature form is considered.

the embraced whorl. In the matter of suture-line, however, there is a marked difference. The siphonal lobe has its terminal lobule deeply divided, a feature wanting in *modesta;* and the inner lobule of *L* in this species is proportionately much more developed than in that one; the terminal lobule is isosceloid and less intra-axial, the outer lobule is more deeply divided into two more equal parts.

In general details the suture-line agrees fairly with that of immature *dominans*. The outer lobule is similarly bipartite, but it is scarcely so large—especially the lower branch. The agreement in septation, however, seems close enough to justify the supposition that *loculosa* may be the retrogressive descendant of *dominans*.

Sonn. loculosa is from Bradford Abbas. Part of its side view is depicted in Pl. XCII, fig. 5; its whorl-section, fig. 6; its suture-line, fig. 7.

Species innominatæ.

Sonninia, sp. Plate CIII, fig. 24.

1892. Sonninia dominans. This Monograph, Plate LXVII, figs. 1, 2, p. 322 (*pars*).

This fossil has considerable external resemblance to *Sonn. dominans* type, but it is rather less costate, while the costæ are regular, and by no means connate. The septa agree fairly with those of *dominans*—at any rate, they show that the fossil belongs to the longilobate section, namely, II, D, *B*, p. 391. The length of the septa separates the form from *Sonn. revirescens*. Comparison with fig. 1 of Pl. XCIV will show that it is now separated from *Sonn. dominans* on account of the difference in costation mentioned above.

Sonninia, sp. Plate CIII, fig. 20.
See Plate LXVII, figs. 3—5.

The external appearance of the fossil shows most likeness to *Sonn. renovata*, juv., Pl. XCIII, figs. 4—6, but it is less spinous, and the whorls are somewhat more compressed. The septa,[1] however, differ, for the terminal lobule of *L* is not so anisosceloid; the lateral lobules are consequently more opposite, and they are also distinctly shorter. There is a likeness to *Sonn. alternata;* but the costæ are more regular in size, and the septa are very different: in this form the terminal lobule of *L* is much less anisosceloid, the lateral lobules are nearly opposite and

[1] Owing to breakage of the fossil the upper boundary of the superior lateral saddle of the upper septal margin (Pl. LXVII, fig. 5) is incorrectly shown by the specimen. A more precise delineation is given in Pl. CIII, fig. 20, with supplementary details.

more isometric, while in *Sonn. alternata* the terminal lobule is extremely anisosceloid, the lateral lobules are very anisometric, and anything but opposite ; also the lobes of the suture-line are very much shorter.

"A variety of *Sonninia renovata*" is perhaps a sufficiently correct designation for this fossil for the present.

SONNINIA, sp.

1892. SONNINIA SIMPLEX. This Monograph, Plate LXX, fig. 4 only (suture-line).

This fossil was described as *Sonn. simplex* (page 326), and it bears very close resemblance to the type. Its suture-line, however, does not agree with that of the type, which has been since worked out, and is depicted on Pl. CIII, fig. 11. In this respect it has more to do with *Sonn. dominica* and *Sonn. multicostata.* If it be a development of those forms, its external likeness to *Sonn. simplex* is truly extraordinary.

SONNINIA, sp. Plate LXXII, figs. 1, 2.

This form has considerable external resemblance to *Sonn. substriata* (page 330), but is more costate and more carinate. It may be placed in proximity to that species until septal evidence to the contrary be forthcoming.

SONNINIA, sp. Plate LXXIX, figs. 7, 8 (see page 349).

The external appearance indicates alliance with *Sonn. crassiformis* (page 348), but it is not a young form of that species.

SONNINIA, sp. Plate LXXXIX, figs. 9, 10.

This fossil may be the young of *Sonn. simplex.* The rudimentary state of the spinous stage, which may reasonably be considered as vestigial, is particularly noticeable. The costæ are shown rather too strongly in the drawing. The

specimen may be compared with *Sonn. modesta*, juv. (Pl. XCVI, figs. 1, 2); but it is costate at an earlier age. The degree of inclusion prevents it being placed as the young of a large number of somewhat latumbilicate species.[1]

SONNINIA, sp. Plate XCV, figs. 9, 10.

This little form possesses costæ and subbullicostæ about as 3 to 1. The only species to which it bears any likeness is *Sonn. densicostata ;* and it appears to have whorls which are rather too thick to allow its being placed as the young of that form.

SONNINIA, sp. Plate XCVII, fig. 5 (suture-line only).

For comparison with the suture-lines of *Sonn. dominans* (p. 435) the septal margin of an immature, externally very similar fossil was illustrated in Pl. XCVII, fig. 5. It shows that identification by external appearance only would be extremely hazardous. The specimen is an ally of *Sonn. revirescens* (p. 417), as may be learnt by a comparison of the present figure with fig. 9 of Pl. C, though the terminal lobule of *L* is shown isosceloid in the former; but this is due to the septal margin being only imperfectly shown after the filing-away of test. The specimen only differs from *Sonn. revirescens* by a broader and flatter periphery. From *crassa* it differs in mode of coiling and in having connate costæ. The specimen is from Bradford Abbas.

SONNINIA, sp. Plate CIII, fig. 19 (suture-line only).

This fossil is similar in external appearance to *Sonn. simplex* and *Sonn. subsimplex ;* but it is remarkable for the extreme difference in septation and the extraordinary complexity of its long and involved lobes. These characters almost suggest its inclusion in the longilobate series II D, *B* (p. 430); but there is a certain difference in the character of the terminal lobule; and, further, the specimen is thinner than any of that series. The shell is from Bradford Abbas.

[1] In estimating umbilication in young forms the greatest care is necessary. A millimetre difference between two young specimens may become 10 or 20 mm. difference in their respective adults. This applies also to other dimensions.

SUMMARY.

The illustration of the *Sonniniæ* of the *Concavum*-zone has occupied rather more than 47 plates, even though considerable reductions from natural size—not always, it is to be feared, to the advantage of the student—have been made. As many as 110 specimens[1] yielding 71 named species have been represented in 327 figures; yet this goes but a little way towards making anyone acquainted with the various forms of *Sonninia* which are comprised in the fauna of the *Concavum*-zone. Setting aside the fact that the tale of species is obviously incomplete, there are very many cases in which the young and immature forms have not been illustrated. Continental correspondents have particularly asked that the young and immature forms of the species of *Concavum*-zone *Sonniniæ* should be figured as well as the adults; but, partly on account of space, it has not been possible to comply with their requests. If they knew the work that is still before me, even to illustrate the Ammonite-fauna in the same confessedly imperfect manner, they would not be surprised at this.

There are three species of *Concavum*-zone *Sonniniæ* of which the septa of the types remain unknown, namely, *Sonn. decorata, Sonn. crassinuda, Sonn. densicostata.* The first two have been placed with species to which they bear external resemblance; the last, when critically considered, is found to have no close external resemblance to any of the other species of the *Concavum*-zone, but it seems to be more nearly allied to species of higher horizons—to be described later on.

The following Table shows the various skeleton outlines of the different *Sonniniæ* which have been mentioned in the previous pages. For facility of comparison they have been brought together on one page, and thus the differences between them may be readily noted. No attempt has been made to arrange them according to their various degrees of development—that the reader can easily see for himself; and so they have been placed in the order in which they have been referred to in the foregoing pages. The explanation on page 442 gives the source from which each one has been taken.

[1] Not counting those from which suture-lines only were taken.

EXPLANATION OF FIGURES ON TABLE VIII. (See opposite page.)

Fig. 56. *Sonninia dominatrix*, from Pl. XCIV, fig. 4.
„ 57. „ *papilionacea*, from Pl. XC, fig. 3.
„ 58. „ *costata*, from Pl. LXXV, fig. 2.
„ 59. „ *parvicostata*, from Pl. CIII, fig. 22.
„ 60. „ *crassa*, from Pl. C, fig. 10.
„ 61. „ *diversa*, from Pl. CIII, fig. 8.
„ 62. „ *crassibullata*, from Pl. CIII, fig. 17.
„ 63. „ *crassiformis*, from Pl. LXXIX, fig. 6.
„ 64. „ *spinea*, from Pl. LXXXVI, fig. 6.
„ 65. „ *dominata*, from Pl. XCVII, fig. 3.
„ 66. „ *dominica*, from Pl. CIII, fig. 14.
„ 67. „ *palmata*, from Pl. XC, fig. 9.
„ 68. „ *subdecorata*, from Pl. LXXXIV, fig. 11.
„ 69. „ *magnispinata*, from Pl. XCVIII, fig. 3.
„ 70. „ *plicata*, from Pl. XCVII, fig. 8.
„ 71. „ *revirescens*, from Pl. C, fig. 9.
„ 72. „ *biplicata*, from Pl. LXXVIII, fig. 3.
„ 73. „ *ptycta*, from Pl. XCVI, fig. 7.
„ 74. „ *gibbera*, from Pl. LXXXVIII, fig. 3.
„ 75. „ *modesta*, from Pl. XCV, fig. 5.
„ 76. „ *subirregularis*, from Pl. XCVIII, fig. 5.
„ 77. „ *subsimplex*, from Pl. XCV, fig. 8.
„ 78. „ *costigera*, from Pl. CII, fig. 3.
„ 79. „ *obtusiformis*, from Pl. XC, fig. 10.
„ 80. „ *renovata*, from Pl. XCIII, fig. 6.
„ 81. „ *dominans*, from Pl. XCIV, fig. 2.

TABLE VIII.—SKELETON OUTLINES OF THE SUPERIOR LATERAL LOBES OF VARIOUS *CONCAVUM*-ZONE *SONNINIÆ.*

FIG. 56.—*dominatrix.*

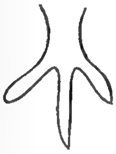


FIG. 57.—*papilionacea.*

FIG. 58.—*costata.*

FIG. 59.—*parvicostata.*

FIG. 60.—*crassa.*

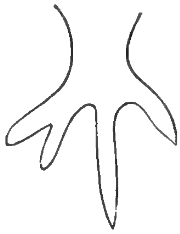


FIG. 61.—*diversa.*

FIG. 62.—*crassibullata.*

FIG. 63.—*crassiformis.*

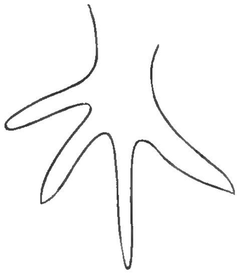


FIG. 64.—*spinea.*

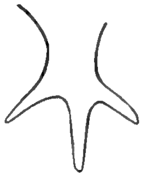


FIG. 65.—*dominata.*

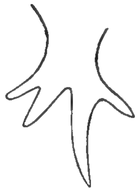


FIG. 66.—*dominica.*

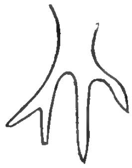


FIG. 67.—*palmata.*

FIG. 68.—*subdecorata.*

FIG. 69.—*magnispinata.*

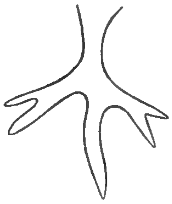


FIG. 70.—*plicata.*

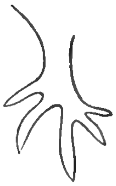


FIG. 71.—*revirescens.*

FIG. 72.—*biplicata.*

FIG. 73.—*ptycta.*

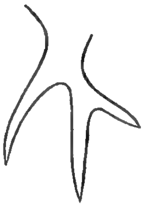


FIG. 74.—*gibbera.*

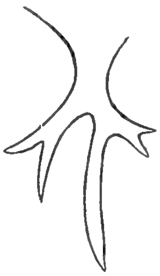


FIG. 75.—*modesta.*

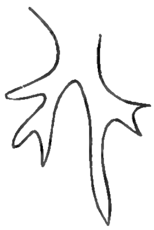


FIG. 76.—*subirregularis.*

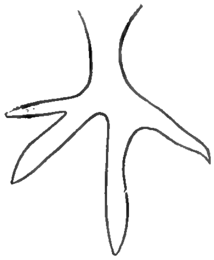


FIG. 77.—*subsimplex.*

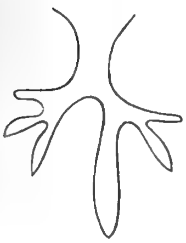


FIG. 78.—*costigera.*

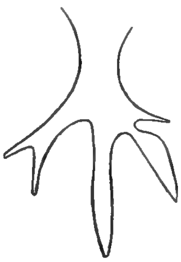


FIG. 79.—*obtusiformis.*

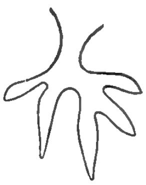


FIG. 80.—*renovata.*

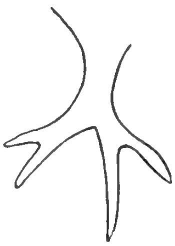


FIG. 81.—*dominans.*

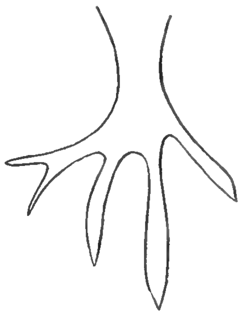
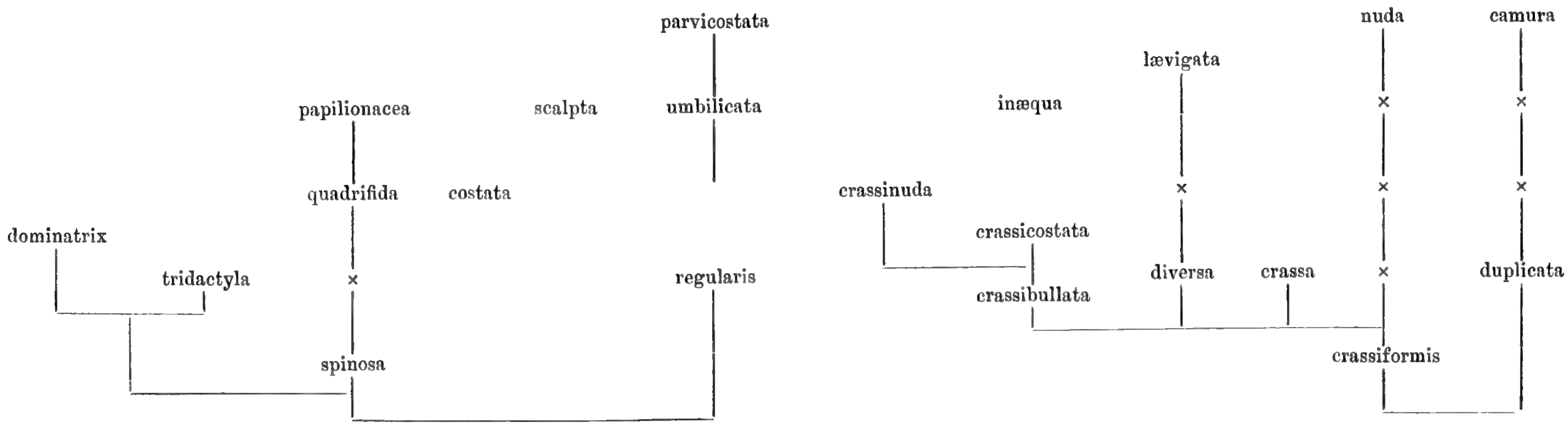


Table IX presents the classification in another manner. It is constructed in the form of a genealogy; but in reality it only expresses the same thing as the Classification (pp. 384—391) is designed to show, namely, the bringing together of the species which may be considered to be genetically connected, because they have the greatest similarity—not merely that similarity in external features, for such forms are only morphic equivalents, and their relative positions may be seen in Table X (p. 449),—but developmental similarity in all features, whether they be striking or obscure. It is the relationship which any particular feature bears to the other features present that is taken into consideration; in other words, that degree of development of one or more features which may happen to be correlated with a given degree of development of other features in any one species becomes a determinant for similarity. Further, in regarding one particular species in relation to any other particular species consideration must be given to the degree of likeness in septation, or whether the differences exhibited are such as would accord with the unlikeness, if any, in whorl-shape or other characters. Guidance in this matter may perhaps be obtained by knowledge of what differences would accompany change in whorl-shape, either from a purely mechanical point of view, or as shown by the ontogeny of any kindred species. In the same manner, difference in whorl-shape and difference in ornament must be considered in relation to the ontogenetic changes shown in the species with which comparison is instituted.

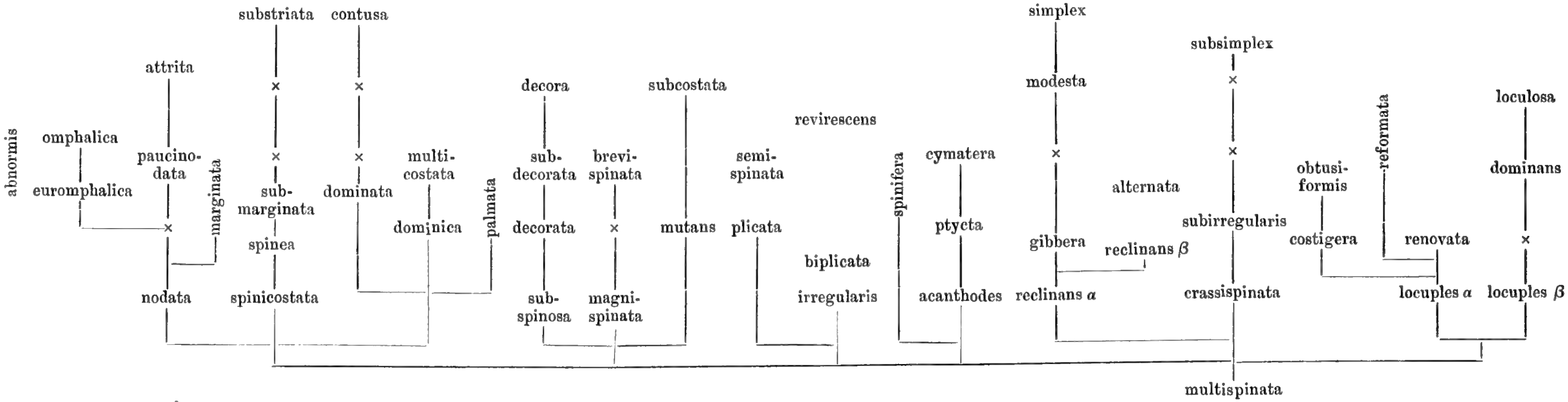
Certain critics of molluscan genealogy appear to suppose that it is only lack of imagination which prevents the tracing of a genetic series from anywhere to anywhere. This statement is not worthy of serious scientific attention, but for the sake of young students the following rather dogmatic remarks may be made. A series of Ammonites, each one having distinctly different septa from its predecessor or successor, cannot be arranged in a direct genetic line, however much their external similarity of form may suggest such a blunder. Nor can Ammonites with different proportions—thick-whorled and thin-whorled, latumbilicate and angustumbilicate species—be arranged indiscriminately; nor can uncarinate, carinate, and carinate-bisulcate forms be arranged in a haphazard manner,—in fact, species cannot be arranged phyletically without a distinct knowledge of the ontogenetic sequence of the various features which they possess. Attention to these matters, and a due observation of rudiments, whether the features be nascent, and therefore such as may be expected to increase in the descendants, or whether they be obsolescent—in other words, vestigial of what has gone before,—will make the possible genealogies exceedingly restricted, and banish imagination from the field altogether. One thing should be carefully remembered. Mistakes will arise from not paying due attention to all the characters; and this is the hardest faculty to acquire. A superficial similarity—in Ammonites, generally

Table IX.—*Genealogical Table of the* Concavum-*zone* Sonniniæ.

I. A, B (pages 384—386).



II. A—D (pages 386—391).



similarity of external form—is a most misleading thing, yet it is sometimes so striking that unless care be exercised it will be certain to mislead, as it has misled nearly every beginner in the making of classifications, especially in the case of Ammonites.

It should be noted that it is the object of the present generic classification to express our ideas about genealogy. These ideas are theoretical, but only in the same way as the statement that a man with a certain type of nose is of Jewish or Negro descent. In the matter of, say, poultry, a breeder can tell the descent from the characters of the hen before him; and the Ammonite specialist claims no more. It must, however, be borne in mind that it is not the characters which determine the descent, but the descent which has determined the characters. A and B were parents of C, and D and E were not. *We* do not know whether A, B or D, E were the parents, but we try to interpret the characters of C so as to find out. It may have been stated that the descendants of A, B, all had a certain character, and we may be expected to class C with D, E because it does not show this character as it ought to; yet the absence of the character can never make C the offspring of D and E if it was really the offspring of A and B. It is the definition which is at fault. Other characters may show plainly that C must be classed with A, B, and can never have belonged to stock D, E, just as a very slight feature in an animal betrays to the experienced breeder a fact in the beast's ancestry, no matter how strongly other characters may seem to point to the contrary.

Setting aside its genealogical characters, Table IX is constructed to show at a glance the affinities of the various species, and, as they are placed in vertical position to correspond, as far as possible, with their different degrees of retrogression from the spinous, gibbous-whorled, evolute form, it indicates at once those species which possess nearly the same external similarity of form. Practically speaking, all the species which are in the same horizontal line are externally homœomorphous, while all those which are in the same vertical line are internally homœomorphous, and possess, besides, such similarity in general as may be supposed to accompany a definite direction in development.

It might be supposed that because all these species are described as "from the *Concavum*-zone," therefore they were contemporaneous. Such an assumption is hardly admissible; it is based upon the supposition that the strata of what has been called a zone, or any slight thickness of Ammonitiferous rock, had been deposited during a very short space of time.[1] This cannot have been the case—

[1] In the 'Great Oolite Mollusca,' p. 3, Palæontographical Society, 1850, Morris and Lycett remark, "The beds of closely-packed Ammonites, of every stage of growth, which occur in certain of the Jurassic rocks, would appear to be the effect of occasional rapid earthy deposits which took place during that seasonal period when the molluscs lying torpid and contracted within their shells were at once entombed in that condition." The statement is repeated in the 2nd edit. 'Geology of England and Wales,' by H. B. Woodward, 1887. Yet when these thin beds have been traced

the strata of what is called the *Concavum*-zone must have taken an immense amount of time to deposit if the time be reckoned by years; but it was, of course, short in comparison with geologic time as a whole. Recently, however, I have shown in a paper to the Geological Society (vol. xlix)[1] that the strata of the *Concavum*-zone are divisible into two portions—a lower part characterised by the abundance of forms of the *Lioceras-concavum*-type, an upper part characterised by species of *Hyperlioceras*. Munier-Chalmas[2] goes further, and appears to speak of three horizons, so that it is very probable that only about one-third of the 71 species of *Concavum*-zone *Sonniniæ* were sufficiently contemporaneous to live during what I have for chronological purposes designated "a hemera,"[3] and the duration of a hemera I imagine to have been a very considerable space of time from biological considerations.

Taking, however, the two hemeræ during which the strata of what is called the *Concavum*-zone were deposited, there is reason to believe—not because the species have been obtained *in situ*, for the greater number of the large specimens were obtained from workmen, but because of matrix and other details—that a very large proportion of the species lived during the *discitæ* hemera; further, that few of the spinous species lived in this hemera, but that it was characterised by the costate, subcostate, and smooth forms. Further details on this matter will be given in a table of chronological succession which will appear at the end of this volume.

Table X furnishes to a certain extent an analysis of the *Concavum*-zone *Sonniniæ* according to surface-ornament. It is designed to show readily the forms which, considered merely in regard to such surface-ornament, are morphic equivalents of one another. The principal object of this table is to facilitate identification; as a classification it is, of course, of no value at all, and must not be confounded therewith.

The Table is divided into six main columns according to the ornamentation which these *Sonniniæ* possess, namely:—I. *Tuberculate*, which speaks for itself. II. *Tuberculate-costate*, which includes those species wherein tuberculation is retained until a fairly late stage of ontogeny, so as to form a marked feature of the

horizontally they are seen to be merely slowly deposited representatives of thick beds elsewhere. Further, they are found to contain several distinct successive faunæ indicative of much biological evolution, itself demanding a very considerable length of time. For instance, the Cotteswold Cephalopod-bed, which was no doubt in the minds of Morris and Lycett, contains five distinct Ammonite-faunæ at the least, whereby it is shown to be contemporaneous with several hundred feet of strata in other parts of this country and on the Continent.

[1] "The Bajocian of the Sherborne district."

[2] "L'Étude préliminaire des Terrains jurassiques de Normandie," 'Compte rendu sommaire des Séances, Soc. géol. France,' No. 14, 1892.

[3] 'Quart. Journ. Geol. Soc.,' vol. xlix, *op. cit.*

shell. III. *Costate*, in which the amount of tuberculation is entirely subordinate. IV. *Subcostate*, in which the degree of costation is decidedly feeble. V. Smooth, in which the test is practically smooth, or costation takes the form of irregular wave-like bulgings. VI. *Renovate*, in which are placed species that show in a marked degree a tendency to increased ornamentation as they grow older.

Of these six columns, the first three and No. V are subdivided, each into two parts: I. Tuberculate, *a* and *b* for species more or less strongly tuberculate respectively; II. Tuberculate-costate, *a* for species which have a strong costate stage succeeding the spinous stage; *b* for those which have a weak costate stage; III. Costate, *a* for those in which the central whorls are obviously tuberculate; *b*, species in which the tuberculation is so rudimentary that it is generally unobserved; V into *a*, containing species with a concentric umbilicus, as opposed to *b*, possessing species with an excentric umbilicus. By this means ten columns are obtained, which divided into the number of species, 71, gives about 7 species to each column as an average. It will be noted, however, that there is very considerable difference in the number of species in the columns: III *a* carries off the palm with 16 species, and III *b* has only 2 to boast of.

Having found the column into which its external ornamentation places a specimen to be identified, it is obvious that the next step would be the comparison in turn with the figures of each of the species named in the column. In the case of the columns with a small number of species this would not take long; in the case of a column like III *a* it would be advisable for the student to make a further analysis. First he can separate the species with reclinate costæ from those with costæ more or less upright, putting on the one side *Sonn. cymatera*, and on the other side *Sonn. dominatrix*. Having settled which of these two groups his fossil belongs to, he may proceed to divide again—those with a large umbilicus like *Sonn. euromphalica*, those with a small umbilicus like *Sonn. dominans*. The number of species to choose from would not then be large; but it may be further reduced by dividing according to relative intensity of costation, and lastly by the different degrees of thickness. For illustration of this analytical method of work the largest group has been taken; but of course the same plan may be pursued with the others, though it will not be so necessary. Further, in the above case only the external ornament has been taken into consideration. If, however, the septa be shown, their details should, from the analyses given in pp. 384—391, lead to correct identification. Only a limited number of species will be found in the Classification having a common type of suture-line, and of this number nearly every one would be found to occupy a different column in the Table of Morphic Equivalents on account of external difference. Therefore, if these two tables be used in conjunction, the specimen, if it belong to one of the species figured, should be identified with certainty.

TABLE X.—MORPHIC EQUIVALENTS.

I. TUBERCULATE.		II. TUBERCULATE-COSTATE.		III. COSTATE.		IV. SUBCOSTATE.	V. SMOOTH.		VI. RENOVATE.
a. Strongly tuberculate.	b. Less strongly tuberculate.	a. Costæ strong.	b. Costæ weak or distant.	a. Umbilicus somewhat tuberculate.	b. Umbilicus practically untuberculate.		a. Umbilicus concentric.	b. Umbilicus excentric.	
—	—	—	—	—	—	—	—	—	—
S. acanthodes	*locuples*	*crassa*	*crassibullata*	*abnormis*	*costata*	*decora*	*contusa*	*attrita*	*costigera*
S. crassiformis	*nodata*	*dominica*	*crassicostata*	*brevispinata*	*densicostata*	*inæqua*	*lævigata*	*camura*	[*modesta*, ? ab-normal]
S. crassispinata	*spinea*	*marginata*	*diversa*	*crassinuda*		*loculosa*	*parvicostata*	*nuda*	*obtusiformis*
S. gibbera	*subspinosa*	*mutans*	*spinifera*	*cymatera*		*modesta*		*simplex*	*renovata*
S. irregularis		*palmata*	*decorata*	*subdecorata*		*papilionacea*		*subsimplex*	*revirescens*
S. magnispinata		*ptycta*	*tridactyla*	*dominans*		*scalpta*		*substriata*	[? *reformata*]
S. multispinata		*regularis*		*dominata*		*subcostata*			
S. reclinans		*subirregularis*		*dominatrix*		*umbilicata*			
S. spinicostata				*euromphalica*					
S. spinosa		Costæ strong but connate.		*multicostata.*					
		—		*omphalica*					
		alternata		*paucinodata*					
		biplicata		*quadrifida*					
		duplicata		*reformata*					
		plicata		*semispinata*					
				submarginata					

The above remarks are made because, though the number of species figured is apparently bewildering to one who turns over the plates, it will be seen that by this method of work the number of species to which any given form can possibly belong, or with which it need be compared, is very soon reduced. Instead of looking at the plates the tables should be consulted. Thus by taking external appearance alone the greatest number of species out of the 71, which are alike enough to be classed in one column, is sixteen, and this number can be rapidly reduced by proper methods of work. Taking the septa alone, the greatest number of species that are alike is about five; and of these five no more than two would occupy the same column in the Table of Morphic Equivalents; that, in fact, only happens in about one case.

A consideration of the species of *Concavum*-zone *Sonniniæ* now figured and described, especially if attention be paid to the method of classification adopted, of which the genealogical table may be said to give a bird's-eye view, will suggest that further generic division of *Sonninia* will be required at no very distant date. In the first place, it is not difficult to separate all these *Sonniniæ* of the *Concavum*-zone from the true *Sonniniæ*, which it may be remarked are not the group of *Sowerbyi*, but the species allied to *propinquans:* it is always necessary to work back to *propinquans*, because that is the type of Bayle's genus.

It would not be easy to find any one character applicable to all the species which would separate the whole series from the *propinquans*-group; but dealt with piecemeal they could be separated, and their characters concisely defined. This, however, must necessarily stand over until *propinquans* and its allies are figured. Now it is desired to draw attention to this, that the *Concavum*-zone *Sonniniæ* being separated from *Sonninia* proper lend themselves to further treatment in the way of genera. A few examples will suffice for the present. Thus the series of the *quadrifida*-stock, and all the species at least of I, A, p. 384, stand out very distinctly, characterised by their symmetrical *L;* next, all the series II, A are distinguished by their shallow, narrow-stemmed lobes, and excluding *abnormis*, they have considerable similarity in ornament and proportions. The ornament and proportions separate them specifically among themselves; the details of the suture-line separate them generically from *quadrifida* and allies. Again, II, C, *B* (p. 389) is a series very marked, on account of the pronounced asymmetry of *L* and the degeneration in the septa. Here it may be remarked that a further division, of subgeneric value, could be made. The septation separates the whole series generically, but the proportionate amount of costation correlated with any given umbilication separates the series into two parts: *α* with weak costæ—*Sonn. spinifera;* *β* with strong costæ—*Sonn. acanthodes*, *ptycta*, *cymatera*. The three latter all agree in the strength of this ornamentation, but they are specifically distinguished by the different proportions of tuberculate and costate stages which

they exhibit. From *spinifera*, however, they are more than specifically distinguished; for *spinifera* lacks altogether that very strength of ornamentation which these species possess in common.

The series arranged under II, C, *C* (p. 390), may be regarded as generically distinct because of the asymmetry of *L*, which, however, remains very long. (Of course these features do not separate *acanthodes* and *reclinans,* because in them such characters have not begun to be apparent: they, however, bear indications in their ornament as to which groups they belong to.) Then the series II, C, *C*, is further separable according to the stage of phyletic retrogression at which the abbreviation of the inner lateral lobule of *L* makes the asymmetry pronounced—in series II, C, *C*, α, it is apparent in the spinous stage; in series II, C, *C*, β, it is but slight in the costate stage. All the species grouped under II, D are very well separated by the extreme development of their septation and the tendency to "renovation"—to acquire larger costæ, or even tubercles, after a period of decline. It will be interesting for anyone to note how greatly they differ in respect of the septation from such a form as *dominatrix,* to which Pl. XCIV bears witness; and also they differ remarkably from all the short-lobed species classed in II, A. In these cases a generic distinction could be perceived without any difficulty. It is points like these that the classification and the genealogy have been constructed to illustrate. The attempt has been made, as far as possible, to place closest together those species which have the greatest number of characters in common, and to place furthest apart those which have the fewest. This, in fact, is the aim of all classifications—and a true classification should be synonymous with the genealogy. A failure to be so arises from the fact that certain striking characters have made too great an impression on the observer, while he has overlooked some more or less obscure characters which are really more faithful guides. In a natural classification obscure characters may be far more important than those which so readily attract the eye.

Nothing, perhaps, is more remarkable than the fact that in all the literature on Ammonites not one of the *Sonniniæ* of the *Concavum*-zone has been figured before. Such a series of species altogether new to science is rather remarkable, but not one of them can be compared with any figure previously given. The only species at all like them are illustrated in Quenstedt's "Amm. Schwäbischen Jura," pls. lx—lxiii, but many of those species are perfectly well known in Dorset as occupants of a distinctly higher horizon.[1] Those and their allies it will be my task to figure in Vol. II.

That European literature contains no figures of any of the *Concavum*-zone *Sonniniæ* certainly shows how little the *Concavum*-bed is developed on the

[1] "The Bajocian of the Sherborne District," 'Quart. Journ. Geol. Soc.,' vol. xlix, p. 494.

Continent. In fact, in the *Concavum*-bed this country possesses what is almost an unique deposit—a development of strata which, so far as is known at present, cannot, in its entirety, be matched elsewhere. In Normandy the *Concavum*-bed has often been entirely, or to a great extent, destroyed by contemporaneous erosion,[1] and in this country it is absent from many places. It would appear that it is absent or has been destroyed over the greater part of Europe. It will be necessary to know whether it has been destroyed or whether it was not deposited, or if deposited whether it contains *Sonniniæ*. Present evidence seems to point to the fact that the *Sonniniæ* came from the west and settled first in the Anglo-Parisian basin. Munier-Chalmas has just announced the discovery of *Sonniniæ* in the *Murchisonæ*-zone of Normandy;[2] and, if this prove correct, the *Sonniniæ* settled in Normandy before they came to this country. They arrived in this country during the *Concavi* hemera, and would appear to have made Dorset their headquarters, but the curious thing is that they did not arrive in Württemberg until considerably later,—in fact, using the term which I have lately suggested for geological chronology, their arrival in Württemberg was later by two hemeræ than their arrival in Dorset. If the westerly faunal migration of the *Sonniniæ* prove to be a fact, it will be in striking contrast to what obtained among Ammonites generally, and especially among the externally similar *Hammatocerata*. They are found in greater abundance in the north of Italy (Garda See) and along the borders of the Mediterranean, in strata presumably equal (according to Haug[3]) to our *Concavum-Murchisonæ*-zones, than they are with us. In fact, the *Hammatocerata* appear to have moved eastwards. Further biological information concerning those species will be given later, when it is hoped that our knowledge of these matters will be more precise than it is now. It is impossible, however, to resist this opportunity of pointing out that only by a minute analysis of the fauna and the distribution of species in time, after the plan which the hemeral system is designed for, can we hope to be able to discover and, what is more important, to express the interesting biological results which the study of faunal migration should yield to us.

Postscript.—Since the above was sent to the printer I have received, by the kindness of Mr. W. Möricke, his interesting pamphlet entitled 'Versteinerungen des Lias und Unteroolith von Chile.'[4] Herein are figured two species of *Sonninia*,

[1] Munier-Chalmas, "L'Étude préliminaire des terrains jurassiques de Normandie," 'Compte rendu sommaire des Séances de la Société Géologique de France,' No. 14, p. clxv, 1892.

[2] *Op. cit.*, p. clxiv. It is possible that they may be species of *Hammatoceras*.

[3] "Sur l'étage Aalenien," *ibid.*, p. clxxvi.

[4] "Beiträge zur Geologie und Palaeontologie von Sudamerika,—Unter Mitwirkung von Fach-

namely, pl. iii, fig. 3, "*Hammatoceras* (*Sonninia*) *polyacanthum*, Waag., *Sauzei*-kalke;" and pl. v, fig. 6, "*Hammatoceras* (*Sonninia*) *Andium*, Göttsche, *Sauzei*-kalke." The identification of the first can scarcely be accepted, for it differs in many respects widely from Waagen's species. It is one of the "renovate" series (p. 448), but it is not comparable with any of the forms figured in this work at present. The identification of the second is, unfortunately, still less to be trusted. It is a costate form which would apparently fall into the column III, *b* (p. 449); but the central whorls are wanting. In its mode of costation it agrees most nearly with *Sonn. multicostata;* but it is a very much thinner shell with quite different proportions.

In Göttsche's work,[1] though there are some species of *Sonnininæ*, there seem to me to be no species of *Sonninia*—nothing, at any rate, like the *Concavum*-zone forms. The only other extra-European species of *Sonninia* which I can call to mind at present is *Ammonites pustulifer*, figured by Bayle and Coquand.[2] At one time the identification of this species with one of the *Concavum*-zone forms seemed likely (see p. 258, foot-note 2); but a strict examination negatived the idea. Two striking characters may be mentioned, and either one of them will be sufficient to indicate that further comparison with the *Concavum*-zone species is unnecessary. First, though nodiferous, the Chili fossil is angustumbilicate; second, the nodi are sessile. Accordingly, though the Chili fossil is only a fragment, there need be no uncertainty; the student can easily see that none of the *Concavum*-zone species figured have sessile nodi—the nodi, or tubercles of different kinds, are all pedigerous (see p. 405, note to *Sonn. spinicostata*).

Thus none of these South American species of *Sonninia* give any clue to the origin of the *Concavum*-zone forms; in fact, they all show characters indicative of further biological advance. All of them are more nearly related to species which do occur in this country at a higher horizon; but, independently of this, a study of the characters of the South American species in comparison with those of the *Concavum*-zone *Sonniniæ* would lead to the supposition that the former were of later date than the latter; that is to say, if specimens like the South American forms were submitted without any indication of horizon or locality, the answer to the question of date would be "between the times of *Concavum* and *Humphriesianum*."

It is not a little remarkable, then, to find that in the case of the South American fossils described by Möricke their horizon is said to be "*Sauzei*-kalke," not only because of the occurrence of certain fossils, but because the strata in

genossen herausgegeben von Dr. Gustav Steinmann," 'Neues Jahrbuch f. Mineral., &c.,' Beilageband ix, Stuttgart, 1894.

[1] 'Beiträge zur Geologie und Palaeontologie der Argentinischen Republik. II. Palaeont. Theil. III. Abtheilung. Ueber jurassische Versteinerungen aus der Argentinischen Cordillere, Cassel,' 1878.

[2] "Foss. Sec. Chili," 'Mém. Soc. Géol. France,' 2e série, vol. iv, pt. 1, pl. ii, figs. 1, 2, 1851.

which they are found are subjacent to beds containing "coronate" Ammonites. In other words, in South America there is the same geological sequence as in this country, namely, beds with *Coronati* overlying beds containing *Sonniniæ*, *Am. Sauzei*, &c.

This correspondence of the faunal sequence in Europe and South America seems to be worthy of attention. In connection herewith it may not be amiss to notice certain ideas of Dr. Johannes Walther in 'Einleitung in die Geologie als historische Wissenschaft,' vol. ii. I have, unfortunately, not seen the original work, and can only submit the following remarks on an abstract which appeared in 'Natural Science,' vol. iv, No. 26, p. 245. Dr. Walther points out that, in possessing a chambered shell, Ammonites are comparable to *Nautilus* and *Spirula*, "which both live at the bottom of the sea, and are very restricted in their distribution; yet their dead shells are found over an enormous area. . . . In the mangrove swamps of Java, on the sandy shores of Ramesveram, among the volcanic ashes of the Canaries, and on the coral reefs of the tropical zone, everywhere are the shells of *Spirula* found scattered. No coastal deposit in the whole Indo-Pacific province is free from *Nautilus*."

At first sight a similar distribution of Ammonite-shells after death would readily explain the correspondence in the faunal sequence in Europe and South America; but only if it be assumed at the same time that Ammonites were pelagic and not littoral forms. If, however, the faunal sequence did depend on distribution of Ammonite-shells, it would make these fossils of even greater importance for purposes of precise zonal correlation, and it would still further weaken the sudden-entombment idea of Morris and Lycett alluded to in p. 446; the beds of closely packed Ammonites to which they allude might be assumed to result from the bringing together during long periods of time of a large number of shells at certain places where there was a proportionately very small amount of sediment to cover them.

However, it may not be unreasonable to make the following remarks on the dispersal idea. Even if a large muster of Ammonite-shells were removed away from the place where they lived, it may be assumed that at the same time a far greater number may have been left behind to be buried on the spot. Dispersal, again, would expose the shells to many vicissitudes, especially when they came into shallow water, or when they were landed on the shore. Now in many Ammonites the appendages of the mouth-border are exceedingly delicate, more delicate than the shells of *Nautilus* or *Spirula*, because they project with very thin supporting stems from the edges of the aperture. Such appendages would be very liable to be broken off; and they would be damaged much more easily than the rounded aperture of *Nautilus*. Ammonites themselves would be differently liable to damage, even those closely related; thus the same accident which would break

off the spatulate auricles from the termination of the species called "*Ammonites Braikenridgii*" would cause no harm to the thickened, arched aperture of "*Am. Humphriesianus*," wholly unprovided with any projections. However, many beds of Ammonites are remarkable for the extremely perfect preservation of the specimens with their delicate mouth-processes intact; in fact, the loss of the process is, in these cases, an accident accompanying extraction, and not an accident that happened before fossilisation. It is arguable that, in beds where Ammonites are so perfectly preserved, the specimens found have not been exposed to the accidents of dispersal, and that they were fossilised on the spot where they lived. This does not say but that many of the shells which did live on that spot may, owing to various causes, have been dispersed, and have been thrown on the nearest coast.

In regard to coastal deposits, it may be remarked that though many shells might be cast on a beach at different times, yet, except in certain cases, these shells would not form a deposit there—not a fossiliferous deposit, because many causes would combine to break the shells into fragments, and the result would generally be the formation of a shelly sandstone. Therefore the finding of shells of *Nautilus* and *Spirula* on coasts at the present day is not necessarily evidence that in those places fossiliferous deposits yielding *Nautilus* and *Spirula* will be found in the future. The evidence of a coastal deposit is not difficult to recognise; but Ammonitiferous beds do not seem to yield it. Therefore if the Ammonites which are found in the rocks have been dispersed from where they lived, they have been stopped on their journey, and have not reached the shore. The argument is, that if they reached the coast, little or nothing, except fragments, would generally be left to tell the tale after a few months; but that if they were preserved under certain circumstances in a coastal deposit there would be other evidence showing that it was such a deposit.

This much can certainly be said as regards the place where Ammonites were fossilised. It was sometimes, if not the more frequently, in places where there was little sediment being collected; in certain cases it was where *Ostreæ*, *Serpulæ*, and small Brachiopoda could attach themselves to the dead shells and grow, and where various organisms could bore them; also the process of fossilisation went on in comparatively shallow water,—that is, probably well within the 100-fathom line,[1] and in comparatively narrow seas, sometimes almost land-locked bays, but

[1] Presumably, in the case of Dorset, Ammonites were fossilised in abundance during Inferior Oolite times at distances between twenty and fifty miles from the supposed land. In Gloucestershire the distance was from less than fifteen miles; in both these cases the preservation of the specimens is on the whole remarkable—the delicate mouth-processes being preserved. On the other hand, in the case of clays—presumably deep water deposits—it may be noticed that in them, or even in the limestone bands they contain, the Ammonites, though fairly preserved on the whole, are usually deprived of mouth-processes, and even of all their body-chamber.

more usually seas similar to the English Channel or the North Sea. One other point has yet to be noticed, namely, they were so fossilised that we now find the geographical ranges of certain species, of certain genera, and even of certain sub-orders of *Ammonoidea* to be very restricted; thus certain forms which are common in Southern Europe are rarely found in England, and other forms which are scarce in the former area are not found at all in the latter.[1]

Such being the facts of fossilisation, the question at issue is whether, after all, the larger number of Ammonites may not have been preserved in the immediate vicinity of where they lived. It may be granted that many of the shells were dispersed after death, only to be broken to atoms on the nearest beaches, and that some of them escaped this fate because they never reached the beaches. It has always been allowed in regard to worn specimens, and those occurring with extreme rarity in beds contemporaneous with rich Ammonitiferous deposits of other districts, that dispersal after death was the easiest explanation of their presence in such cases. In regard to excellently preserved specimens accummulated in large numbers over certain definite geographical areas the case seems to be different. Universal distribution after death would tend to produce damaged specimens,—would, on the whole, lead to greater uniformity of occurrence,—and would produce a greater uniformity of geographical ranges than is found to be the fact.

It will be seen from the above remarks that Dr. Walther's conclusions as summarised in 'Natural Science' (*loc. cit.*, p. 246) require to be accepted with reservation. "The distribution of Cephalopod-shells provided with air-chambers bears no relation to the habits of the living animal." It must bear some relation, though perhaps not a direct one; but the distribution would be different if Ammonites were pelagic from what it would if they lived in shallow water a few miles from a shore; and it might be different according to their shape. "The richness of a deposit in chambered Cephalopod-shells does not depend on the distribution or habits of the living animals." It would depend upon it unless universal dispersal after death had taken place. Given localities rich and poor in living Ammonites, a dispersal after death of 25 per cent. or more would still leave their relative richness unaffected. "The distribution of chambered Cephalopod-shells bears no relation to the changing character of the containing rock, or to the depth of the sea in which it was deposited." Yet it may be objected that Ammonites are found more abundantly in somewhat shallow-water deposits, and that they, in common with other molluscs, would seem to have avoided localities where a large amount of sediment was being collected.

[1] See p. 452; also "Jurassic Ammonites," 'Geol. Mag.,' dec. 4, vol, i, No. 361, p. 298, July, 1894.

PLATE XCIII.

Concavum-zone.

Figs. 1—6.—Sonninia renovata, *S. Buckman.*

Fig. 1.—Side view of a specimen with most of the test present, but in a somewhat inferior condition. Reduced to two-thirds natural size. (It shows a second spinous stage following a costate stage, which is preceded by an irregular, and that by a regular spinous stage. It came from Bradford Abbas, and by its colour and condition evidently from the very top of the *Concavum*-zone immediately under the "Irony bed,"—the bed No. 4 of the section in page 5.) My Collection. (Page 433.)

Fig. 2.—Front view of the same shell in outline. Natural size.

Fig. 3.—Part of the suture-line of the same shell, showing the very long lobes.

Fig. 4.—Side view of an immature shell before the return to knobs has commenced. Natural size. Bradford Abbas. From the Collection formed by Mr. Darell Stephens, F.G.S. Now in my cabinet.

Fig. 5.—Outline of the whorl-section and periphery.

Fig. 6.—Part of the suture-line showing the long lobes.

Fig. 7.—Sonninia crassispinata, *S. Buckman.*

Fig. 7.—Portions of two septal outlines of the specimen of *Sonn. crassispinata* figured in Pl. LVII. This figure is drawn from a photograph, and is the result of a fresh study of the suture-lines for comparison with those of *Sonn. locuples* β, Pl. XCII, fig. 4. To the point of the siphonal lobe the radius is 71 mm. It will be noticed that the superior lateral saddle is incomplete—the outline could not be followed. (Page 425.)

PLATE XCIII.

Fig. 6.

Fig. 4

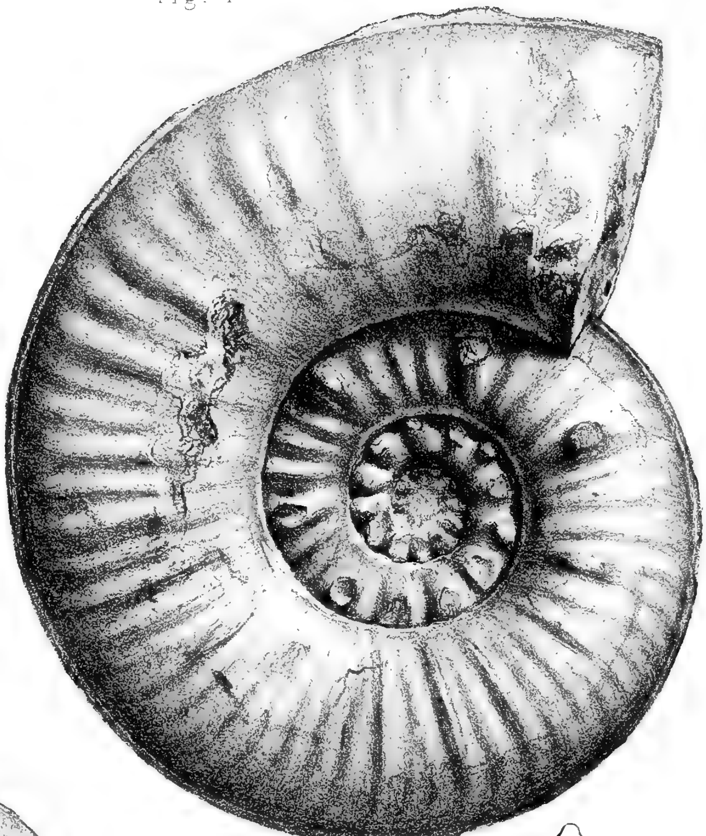


Fig 2

Fig. 3.

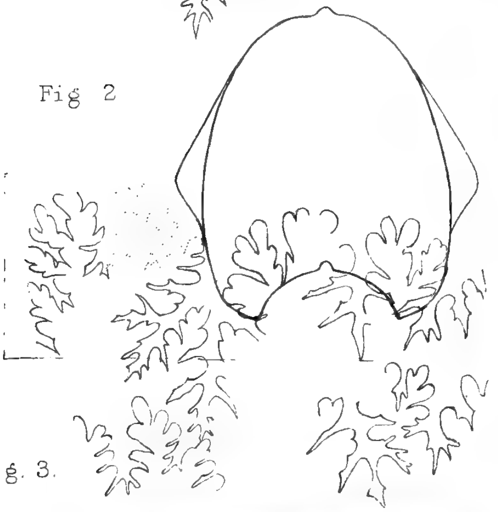


Fig. 1

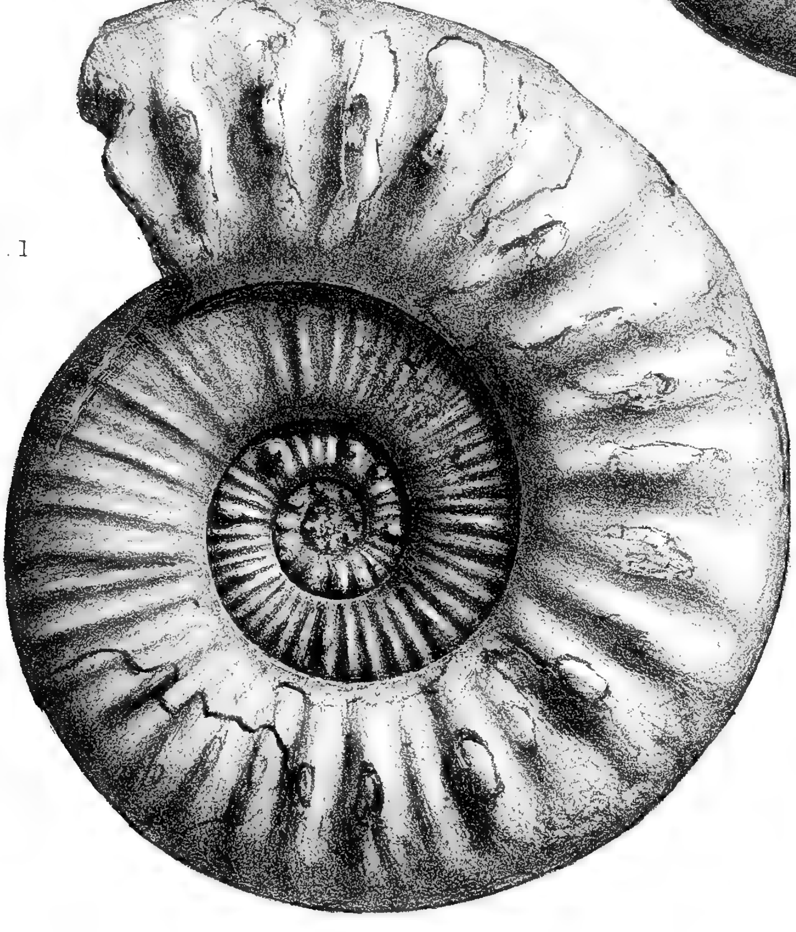
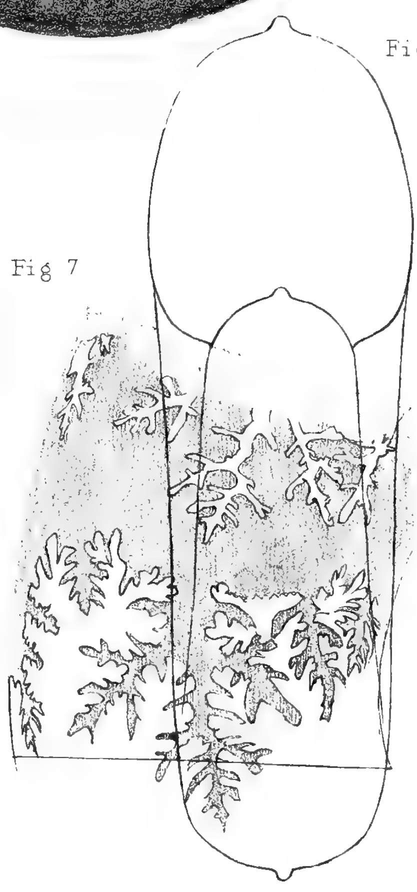


Fig. 5.

Fig 7



F. H Michael del et lith.

Mintern Bros. imp.

PLATE XCIV.

Concavum-zone.

Figs. 1, 2.—SONNINIA DOMINANS, *S. Buckman.*

Fig. 1.—Side view of an immature, wholly septate specimen, reduced to two-thirds of natural size. The details of the inner whorls up to the *o* have been drawn from the other (left-hand) side of the specimen, on account of better preservation. Railway-cutting, Bradford Abbas. My Collection. (Page 435.)

Fig. 2.—The suture-line of the same specimen taken at a radius of 90 mm., showing the length and ornate character of the lobes, also *L* tetradactyloid on account of bipartition of the outer lobule. This drawing is a copy from a photograph.

Figs. 3, 4.—SONNINIA DOMINATRIX, *S. Buckman.*

Fig. 3.—Side view of a specimen = *Sonn. dominans* δ, page 323. Reduced to two-thirds of natural size. The last part of the whorl—from the *o* onwards—has been drawn from the other side of the specimen because of better preservation. Bradford Abbas. Formerly in the collection of Mr. Darell Stephens, F.G.S. Now in my cabinet. (Page 392.)

Fig. 4.—Two suture-lines of the same specimen taken at a radius—for the first one—of 60 mm. They show practically symmetrical, short, tridactyloid superior lateral lobes with isosceloid terminal lobules.

(For other figures of these species see Pl. XCV.)

PLATE XCIV.

Fig. 4.

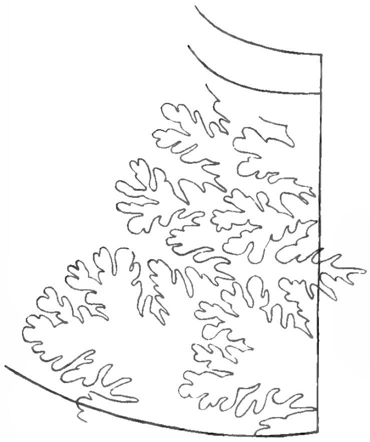


Fig 3.

$\frac{2}{3}$

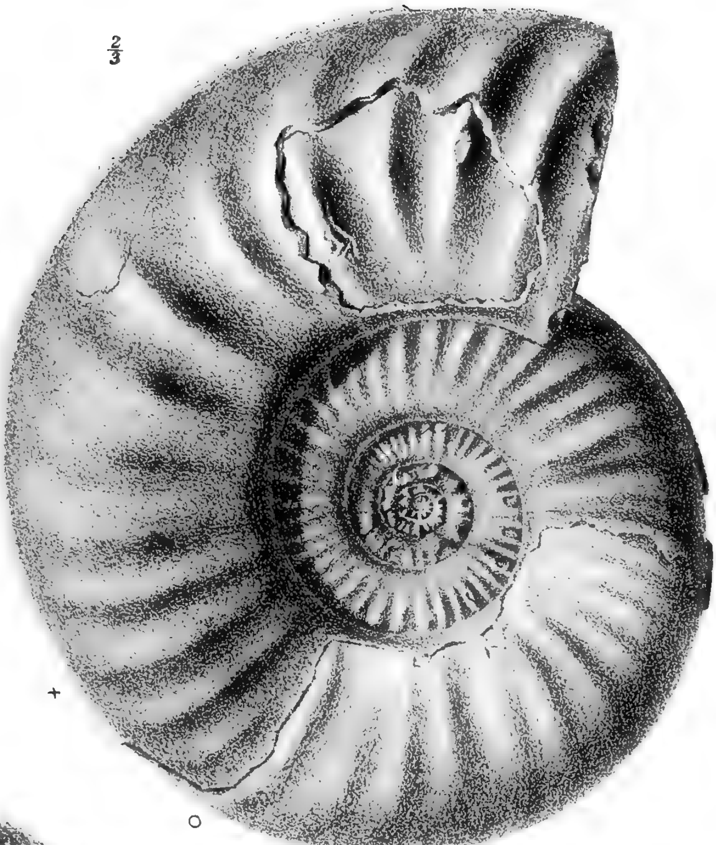


Fig. 1.

$\frac{2}{3}$

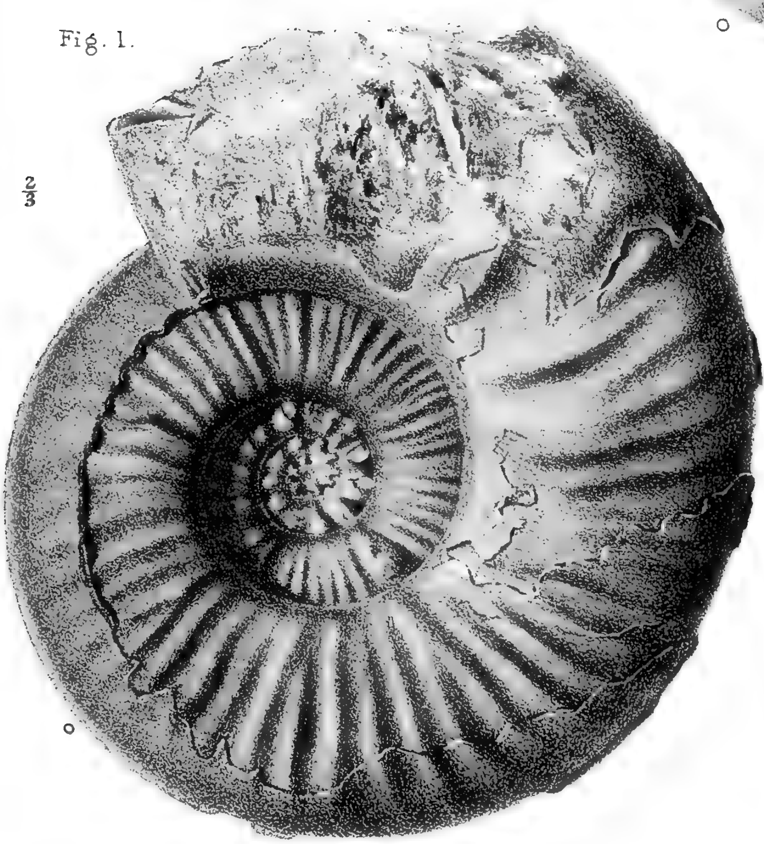
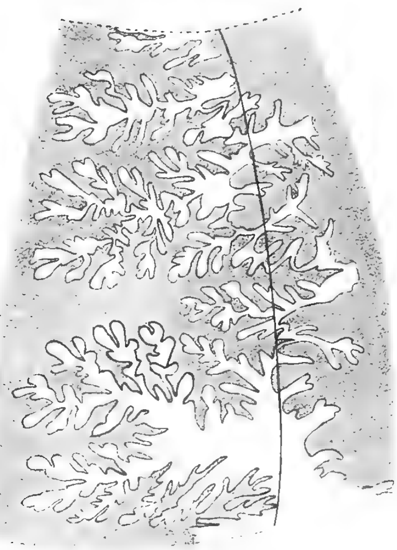


Fig 2



A. H. Searle del. et lith.

Mintern Bros. imp.

PLATE XCV.

Concavum-zone.

Fig. 1.—SONNINIA DOMINANS, *S. Buckman.*

Fig. 1.—Outline of the whorl-section of the specimen depicted in Pl. XCIV, fig. 1. (Page 435.)

Fig. 2.—SONNINIA DOMINATRIX, *S. Buckman.*

Fig. 2.—Outline of the whorl-section of the specimen depicted in Pl. XCIV, fig. 3. (Page 392.)

Figs. 3—5.—SONNINIA MODESTA, *S. Buckman.*

Fig. 3.—Side view of the type-specimen alluded to in page 326. The central whorls are damaged. Reduced to one-half natural size. Bradford Abbas. From my father's Collection. (Compare Pl. LXVIII and Pl. XCVI, figs. 1, 2.) (Page 422.)

Fig. 4.—Outline of the front view to show the whorl-section restored as if test all over, and the size of the fairly distinct carina.

Fig. 5.—The ornate, rather involved septal margins; *L* asymmetrical, the lateral lobules very anisometric, the inner lobules much abbreviated, the terminal lobules very anisosceloid. This drawing is a copy of a photograph.

Figs. 6—8.—SONNINIA SUBSIMPLEX, *S. Buckman.*

Fig. 6.—Side view reduced to one-half natural size. Bradford Abbas. My Collection. (Page 427.)

Fig. 7.—Outline of the front view reduced to one-half natural size, showing a subcarinate ventral area.

Fig. 8.—The somewhat ornate, somewhat involved septal margins; *L* somewhat asymmetrical, but inner lobule not much abbreviated; terminal lobule somewhat anisosceloid. This drawing is a copy of a photograph.

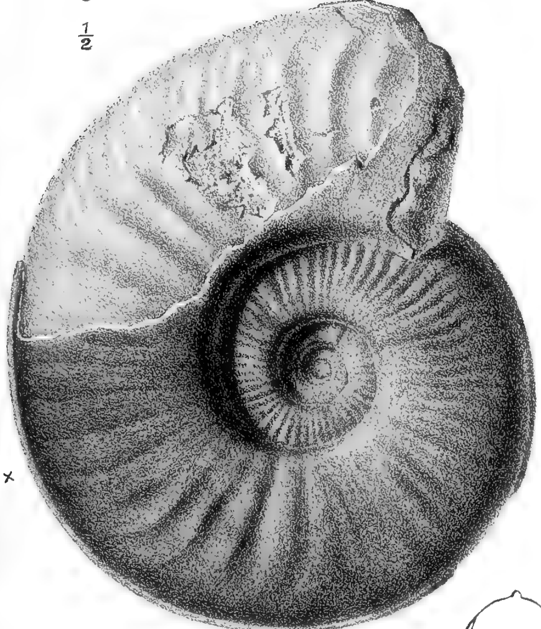
Figs. 9, 10.—SONNINIA, sp.

Fig. 9.—Side view of a young specimen showing plain costæ in the earlier whorls, and developing subbullicostæ later. Bradford Abbas. My Collection. (Page 440.)

Fig. 10.—Outline of the whorl-section of the same shell.

Fig. 3.

1/2



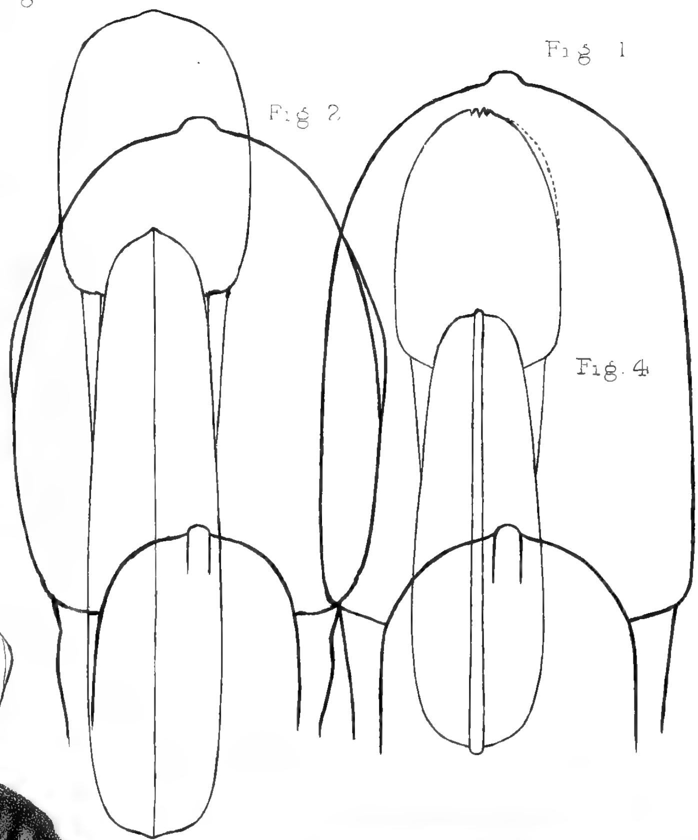


Fig. 5.

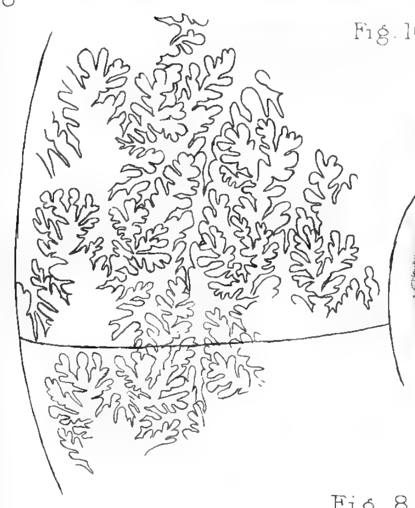
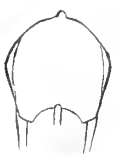


Fig. 10



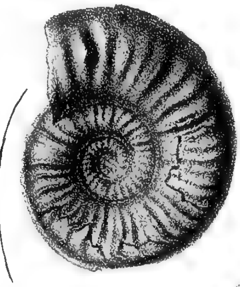
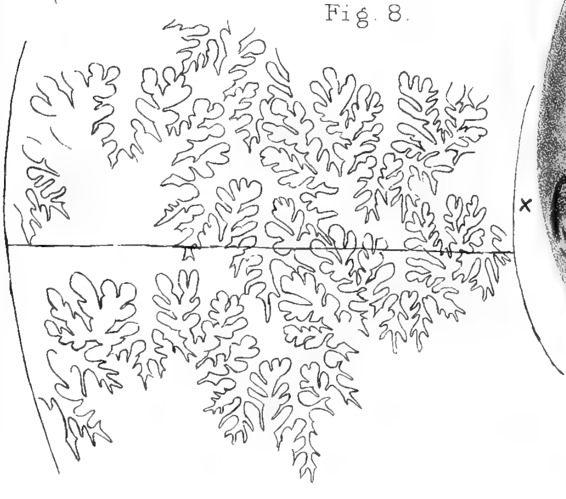


Fig 9

Fig 6

1/2

Fig. 8.



A.H. Searle del. et lith.

Mintern Bros. imp.

PLATE XCVI.

Concavum-zone.

Figs. 1, 2.—Sonninia modesta, *S. Buckman.*

Fig. 1.—Side view of a young shell, showing the early age at which the costate stage commences. Test present. Bradford Abbas. From my father's Collection. (Page 422.) (See also Pls. LXVIII and XCV.)

Fig. 2.—Part of the peripheral area.

Figs. 3—5.—Sonninia regularis, *S. Buckman.*

Fig. 3.—Side view, showing spinous and costate stages. The central whorls of the umbilicus are damaged. Nearly all the test is present. Natural size. Bradford Abbas. My Collection. (Page 395.)

Fig. 4.—Part of the front view, showing the whorl-section and the large carina. The carina of the embraced whorl is not sufficiently elevated in the drawing.

Fig. 5.—Portions of outlines of two septa, showing a nearly symmetrical *L*, with an axial, isosceloid terminal lobule and isometric laterals.

Fig. 6.—Sonninia marginata, *S. Buckman.*

Fig. 6.—Portions of outlines of two septa from the type-specimen depicted in Pl. LXII, showing a somewhat asymmetrical *L* with anisosceloid, intra-axial terminal lobule. (Page 407.)

Fig. 7.—Sonninia ptycta, *S. Buckman.*

Fig. 7.—Parts of two suture-lines from the type-specimen illustrated in Pl. LXXIII, fig. 1, showing the very unequal size of the inner and outer lobules of *L*, and the very intra-axial, anisosceloid terminal lobule. (Page 420.)

(The suture-lines [figs. 5—7] are those of morphic equivalents, showing the different development of the features of *L*. In fig. 5, *L* is symmetrical, isosceloid; in fig. 6, somewhat asymmetrical, anisosceloid, but the lateral lobules fairly isometric; in fig. 7, very asymmetrical, anisosceloid, with abbreviated inner lobule.)

Fig. 1.

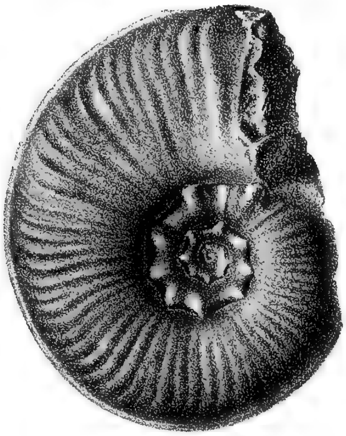


Fig 4

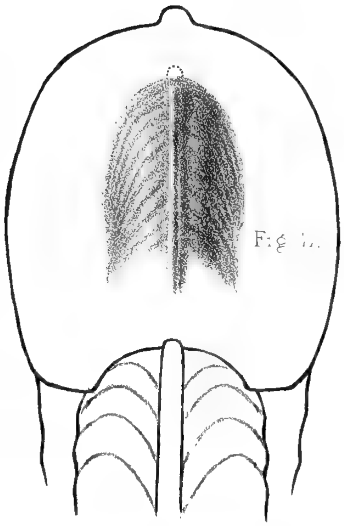


Fig 7

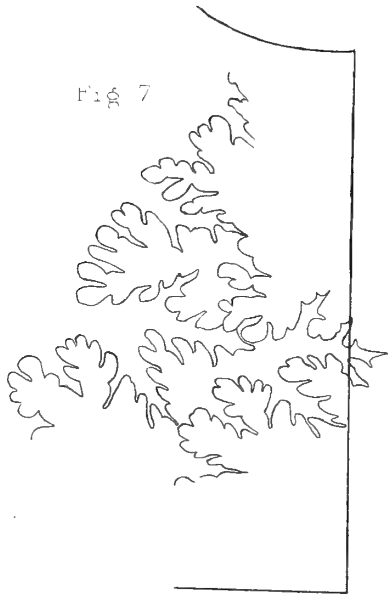


Fig 6.

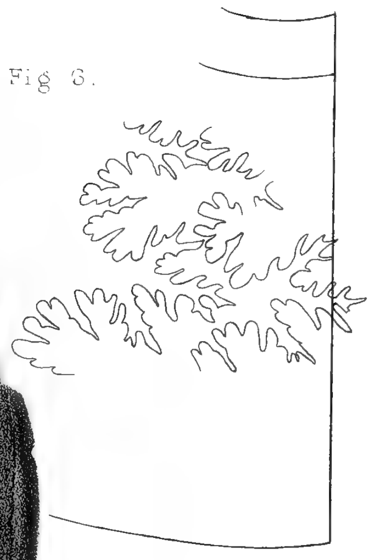
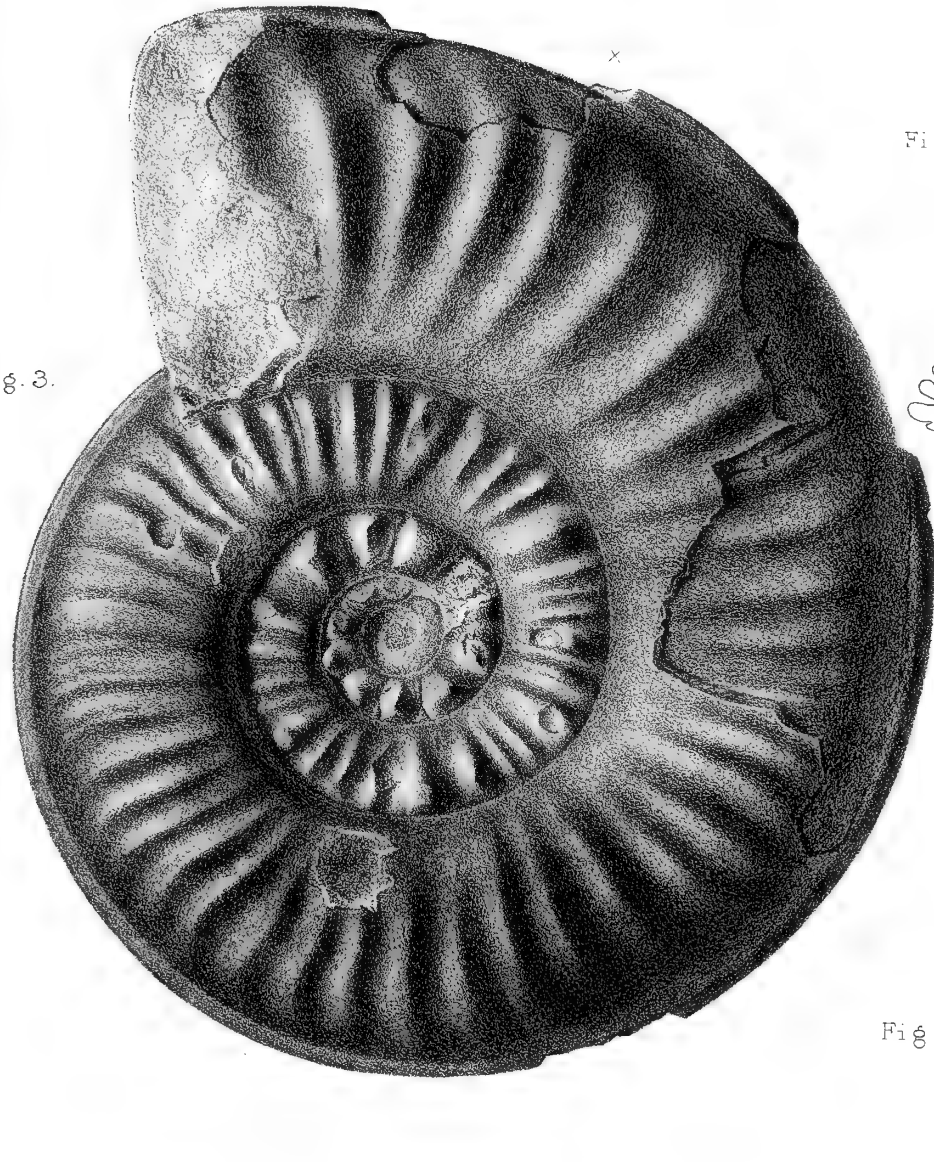


Fig. 3.



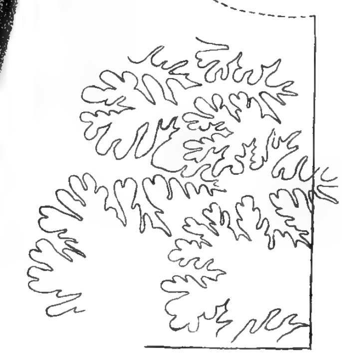


Fig 5.

A.H. Searle del. et lith.

Mintern Bros imp

PLATE XCVII.

Concavum-zone.

Figs. 1—3.—Sonninia dominata, *S. Buckman.*

Fig. 1.—Side view, reduced to one-half natural size. The test is absent from the body-chamber. Bradford Abbas. My Collection. (Page 408.)

Fig. 2.—Outline of the whorl-section. One-half natural size.

Fig. 3.—Portions of the outlines of the last two septa, showing the asymmetrical superior lateral lobe.

Fig. 4.—Sonninia dominans, *S. Buckman.*

Fig. 4.—A somewhat imperfect sketch of the part of the suture-line of the type *dominans* figured in Pl. LXVI. After clearing away the thick test with great labour this is the best delineation I can give. The minor details have been damaged by the scraping and filing, but the principal details may be trusted. This is given for comparison with fig. 3, and also with the septal outlines shown in Pl. XCIV, figs. 2 and 4. It will be noticed that the lobes are long, and the terminal lobule of *L* is ecto-brachysceles. (Page 435.)

Fig. 5.—Sonninia, sp.

Fig. 5.—Sketch of the suture-line of a specimen which is, by comparison with *S. dominans*, only half-grown. It is a shell almost similar to that species, and the suture-line is here given for comparison therewith. (Page 440.)

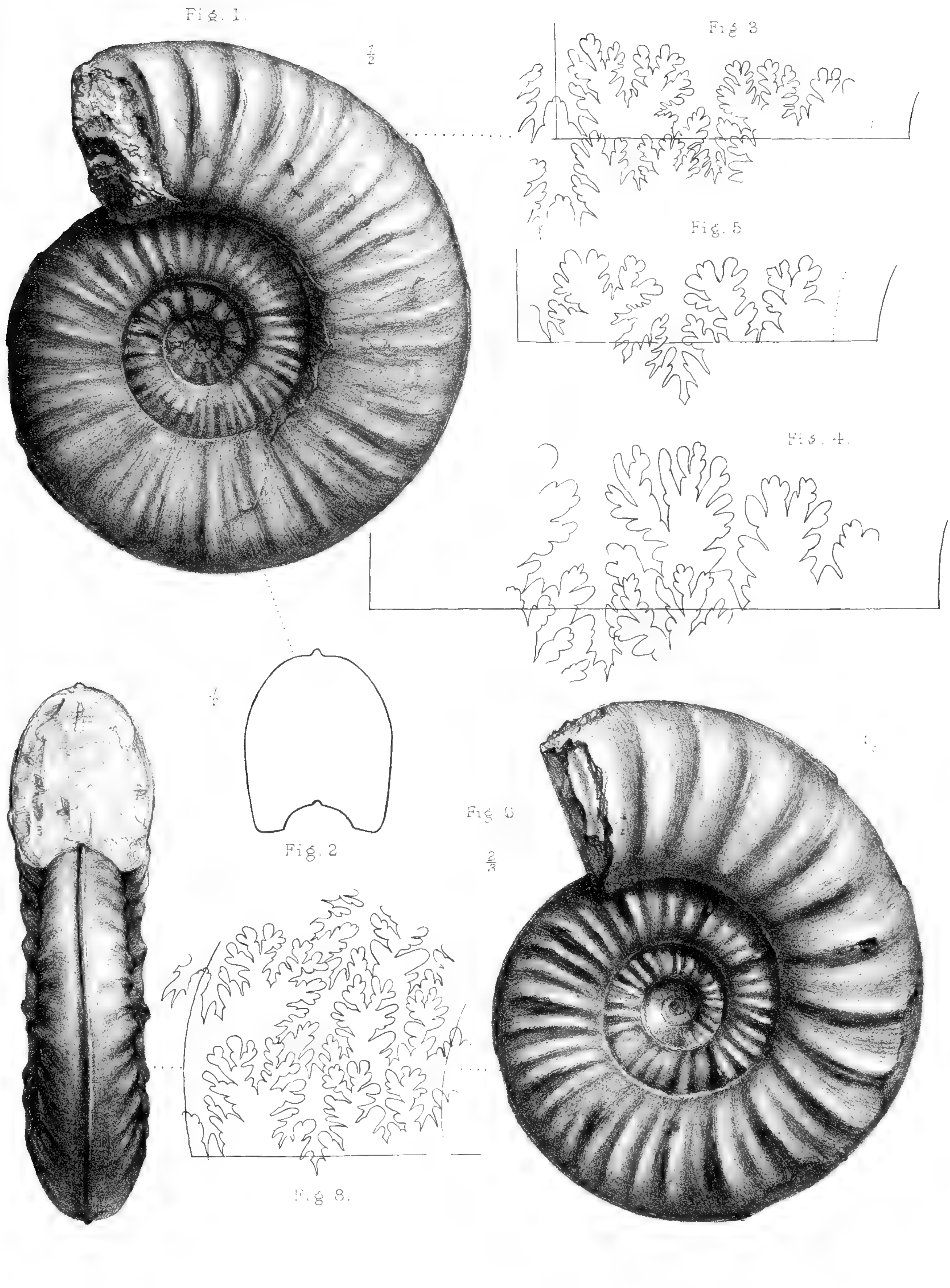
Figs. 6—8.—Sonninia plicata, *S. Buckman.*

Fig. 6.—Side view reduced to two-thirds of natural size, showing the unequal-sized ribs—a feature hardly so clearly brought out in the drawing as it might be. The central whorls, damaged on the side shown, bear evidence of a regular spinous stage on the other. Bradford Abbas, railway-cutting. My Collection. (Page 415.)

Fig. 7.—Front view.

Fig. 8.—Septal margins showing an asymmetrical *L*, the terminal lobule anisosceloid, the lateral lobules short, not equipoised.

PLATE XCVII.



F. H Michael del. et lith.

Mintern Bros. imp.

PLATE XCVIII.

Concavum-zone.

Figs. 1—3.—Sonninia magnispinata, *S. Buckman.*

Fig. 1.—Side view of a specimen with many of the spines preserved intact; also showing nodicostate character of the outer whorl. Bradford Abbas. My Collection. (Page 413.) (Compare Pl. LXXVI.)

Fig. 2.—Outline of the whorl-section.

Fig. 3.—Suture-line showing rather long and narrow-stemmed *L*, the terminal lobule anisosceloid, the saddles much penetrated by the lobes.

Figs. 4, 5.—Sonninia subirregularis, *S. Buckman.*

Fig. 4.—Side view of a large specimen. This drawing is a copy from a photograph, and is much reduced, being 81 mm. in diameter against 271 mm., the diameter of the specimen. Bradford Abbas. My Collection. (Page 426.) (Compare Pl. LXXVII, figs. 6—9.)

Fig. 5.—Suture-line from a photograph, showing *L* with slightly anisosceloid terminal lobule, and a slightly bipartite outer lobule.

Fig. 6.—Sonninia irregularis, *S. Buckman.*

Fig. 6.—Suture-line of the type-specimen figured in Pl. LXI, showing considerable areas unsupported by lobes. (Page 417.)

Fig. 7.—Sonninia reclinans, *S. Buckman.*

Fig. 7.—Part of the suture-line of the specimen figured in Pl. XLVIII, figs. 16, 17, as *Sonn. crassispinata*,[1] showing the long asymmetrical *L* with anisosceloid terminal lobule and long lateral lobules, the outer bipartite. (Page 421.)

[1] It is requested that the explanation of Pl. XLVIII be altered in accordance.

Fig. 4.
$\frac{3}{10}$

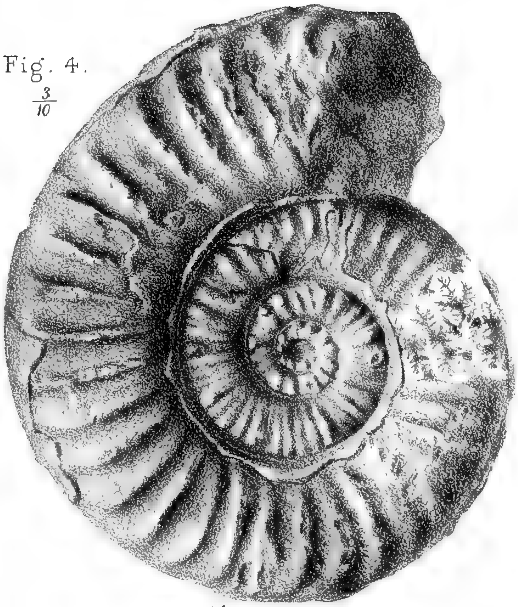


Fig. 6.

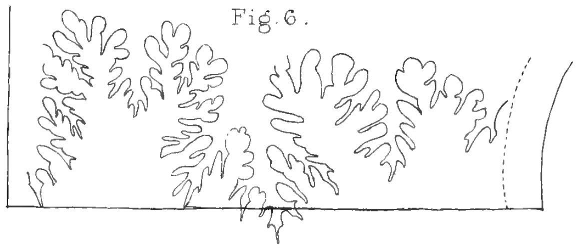


Fig. 5.

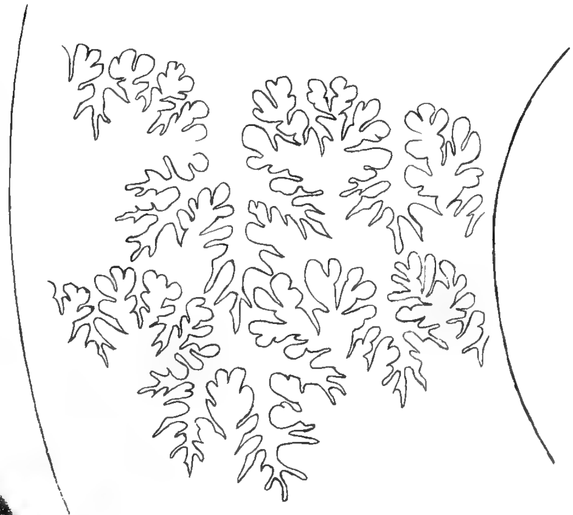


Fig. 1.

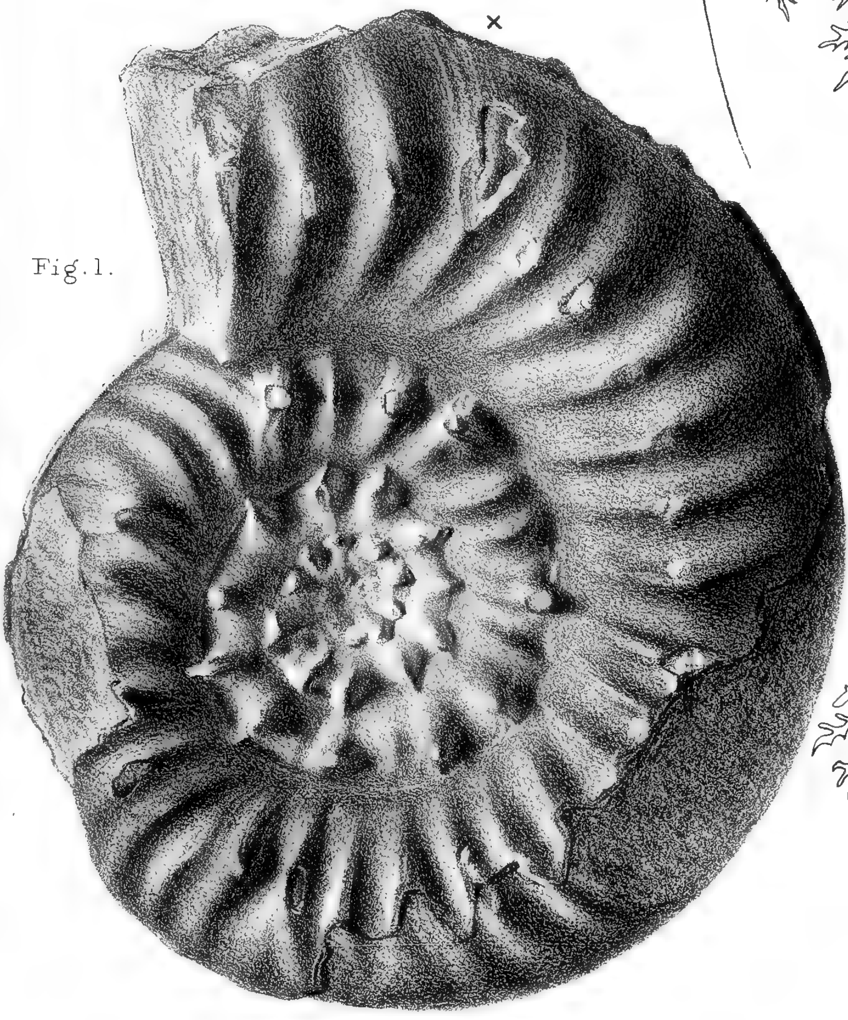


Fig. 7.

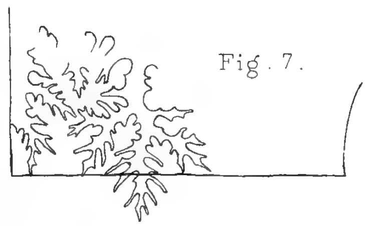


Fig. 3.

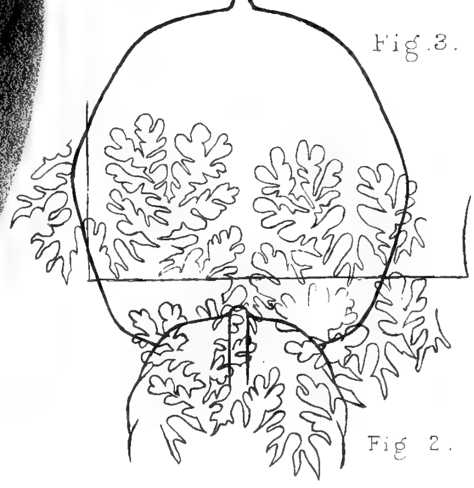


Fig. 2.

A.H. Searle del. et lith.

Mintern Bros. imp.

PLATE XCIX.

Concavum-zone.

Figs. 1—3.—Sonninia duplicata, *S. Buckman.*

Fig. 1.—Side view, showing regular central spines, later irregularly-placed spines, later ribs somewhat in pairs. Bradford Abbas, railway cutting. My Collection. (Page 402.)

Fig. 2.—Outline of the whorl-section.

Fig. 3.—Suture-line showing tetradactyloid *L*, the outer lobule deeply cleft, the terminal lobule isosceloid.

Figs. 4—6.—Sonninia camura, *S. Buckman.*

Fig. 4.—Side view, showing the large ribs of maturity and the peculiar curvature of the umbilicus. (The last quarter-whorl is set a little more angularly than the drawing suggests—it has somewhat of a "scaphitoid" bend.) This drawing is a copy from a photograph, and is much reduced, to about three-tenths of natural size, being 68 mm. in diameter as against 228 mm., the size of the specimen. Bradford Abbas. My Collection. (Page 403.)

Fig. 5.—Outline of the whorl-section. Natural size.

Fig. 6.—Portions of two suture-lines taken from another specimen, showing a superior lateral lobe with a duplicated outer lobule, thus making the lobe tetradactyloid.

Fig. 5

Fig. 6

Fig. 3.

Fig. 2.

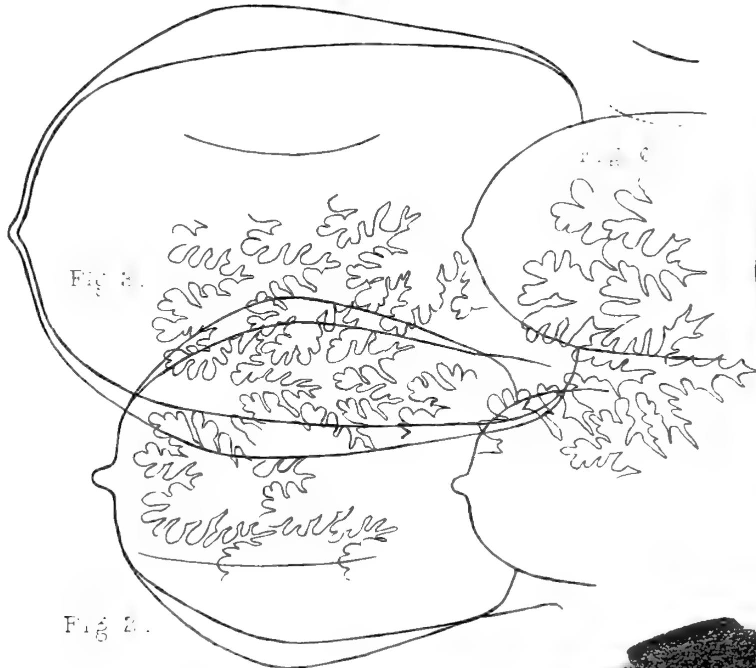


Fig. 4

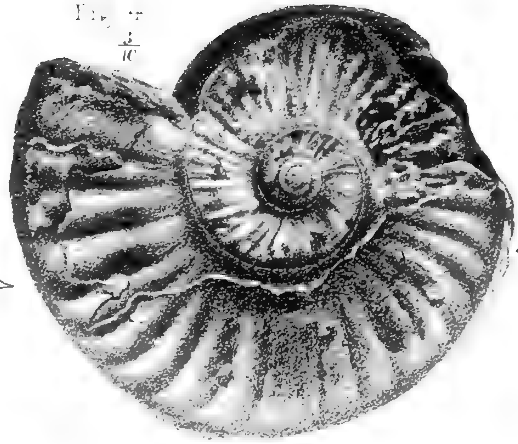
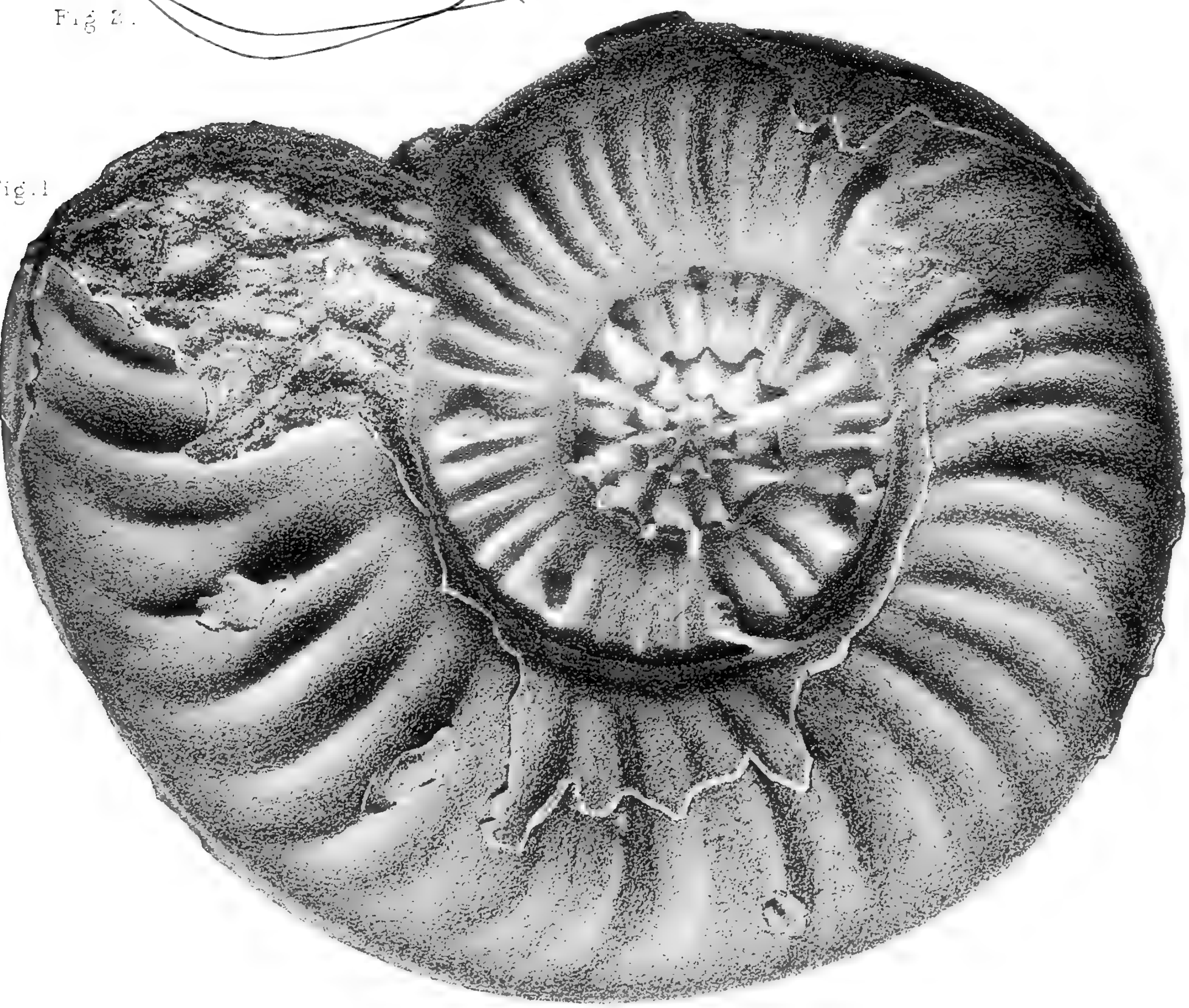


Fig. 1



A.H. Searle del. et lith.

Mintern Bros. imp.

PLATE C.

Concavum-zone.

Figs. 1—4.—Sonninia spinifera, *S. Buckman.*

Fig. 1.—Side view of a nearly wholly septate and nearly wholly testate specimen, presumably adult, showing obsolescence of costæ in correlation with a wide umbilicus. The inner whorls are somewhat damaged. The figure is one-half the natural size. Bradford Abbas, Dorset. My Collection. (Page 418.) (For other figures of this species see Pl. L, figs. 14, 15; Pl. LXXIV, figs. 4—6.)

Fig. 2.—Outline of the whorl-section. Natural size.

Fig. 3.—Portions of two suture-lines of the above specimen taken at a radius of 59 mm., showing asymmetrical *L* with very abbreviated inner lobule, the terminal lobule intra-axial, anisosceloid, inequicellate.

Fig. 4.—Portions of two suture-lines taken at a radius of 102 mm., showing an even more pronounced want of symmetry.

Figs. 5—7.—Sonninia cymatera, *S. Buckman.*

Fig. 5.—Side view of a presumably nearly adult specimen, reduced to one-half natural size, showing strongly reclinate costæ. The central whorls are wanting, and for the purposes of this figure it has been necessary to take details from both sides of the specimen. Bradford Abbas. From my father's Collection. (Page 420.) (For other figures of this species see Pl. LXXIII, figs. 2, 3.)

Fig. 6.—Outline of the whorl-section, of natural size, with test on the peripheral area only.

Fig. 7.—Portions of two suture-lines, showing very asymmetrical superior lateral lobe, the inner lobule being much abbreviated, the terminal lobule being intra-axial, very anisosceloid, and very inequicellate.

Fig. 8.—Sonninia acanthodes, *S. Buckman.*

Fig. 8.—Portions of two suture-lines of the type-specimen figured in Pl. LX, taken at a radius of 94 mm.,[1] showing an asymmetrical *L*, the lateral lobules being inequipoised, the inner lobule the smaller, and the terminal lobule intra-axial, anisosceloid, and somewhat inequicellate. (Page 419.)

Fig. 9.—Sonninia revirescens, *S. Buckman.*

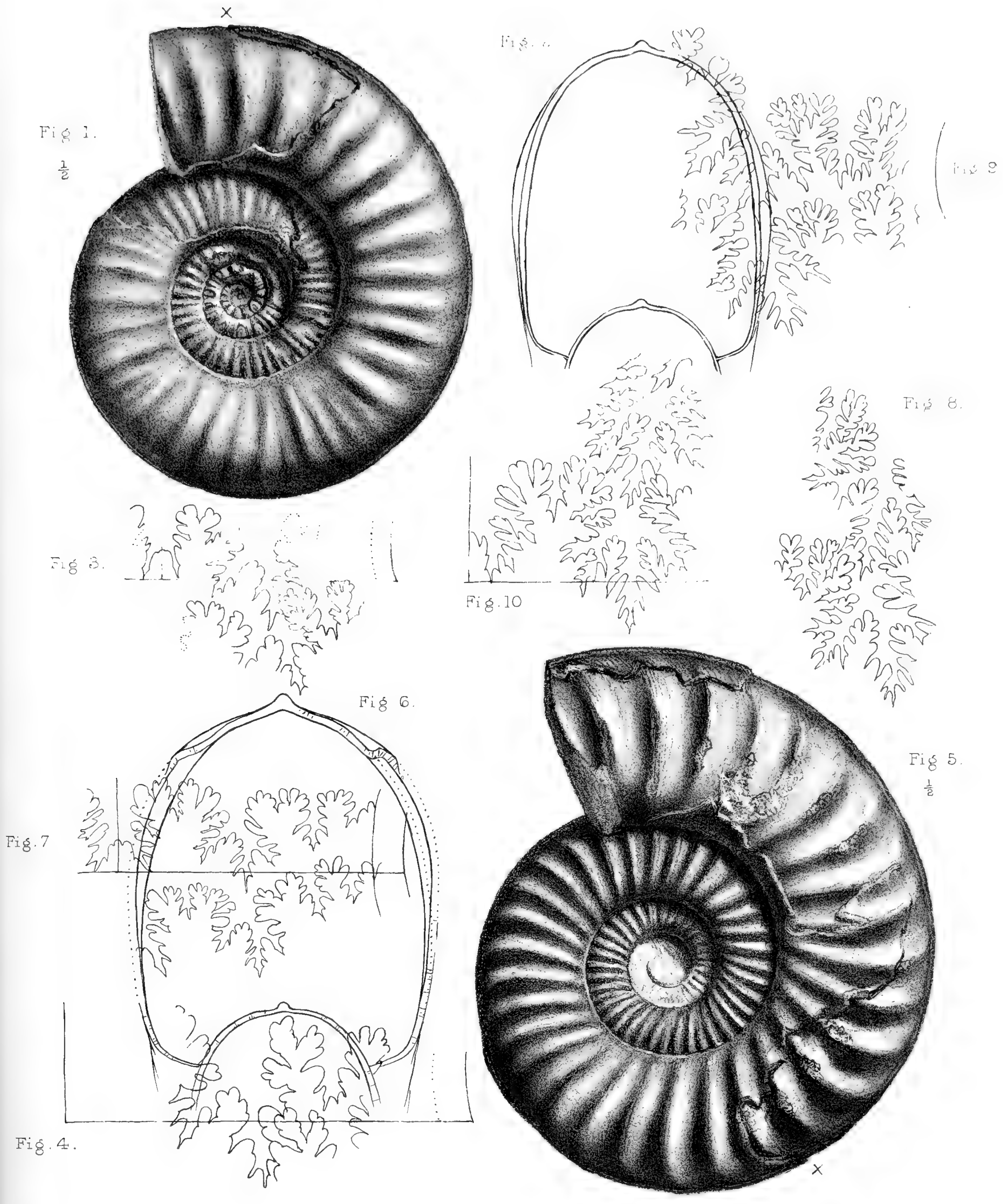
Fig. 9.—Portions of two suture-lines of the type-specimen illustrated in Pl. LXX, fig. 1, taken at a radius of 87 mm.,[1] showing a nearly symmetrical *L*, with a slightly bipartite outer lobule, and somewhat anisosceloid terminal lobule. (Page 417.) (Compare Pl. XCVII, fig. 5.)

Fig. 10.—Sonninia crassa, *S. Buckman.*

Fig. 10.—Portions of two suture-lines of the type-specimen depicted in Pl. LXXXII, fig. 1, taken at a radius of 89 mm.,[2] showing a nearly symmetrical *L*, with a bipartite outer lobule, and isosceloid terminal lobule. (Page 398.)

[1] The upper one. [2] The lower one.

PLATE



F H. Michael del et lith.

Mintern Bros imp.

PLATE CI.

Concavum-zone.

Figs. 1—3.—Sonninia tridactyla, *S. Buckman.*

Fig. 1.—Side view of a presumably immature shell, wholly testate, wholly septate. Bradford Abbas, Dorset. My Collection. (Page 393.)

Fig. 2.—Outline of the whorl-section.

Fig. 3.—Suture-line showing symmetry of *L.*

Figs. 4—6.—Sonninia inæqua, *S. Buckman.*

Fig. 4.—Part of the side view of an immature shell, mostly testate, showing the slight undulate costation. (Page 400.)

Fig. 5.—Outline of the whorl-section.

Fig. 6.—Suture-lines showing asymmetry of *L*, the terminal lobule being intra-axial, anisosceloid.

Figs. 7—9.—Sonninia lævigata, *S. Buckman*, var.

Fig. 7.—View of the umbilicus of an immature shell, presumably a variety of *S. lævigata.* The outer whorl shows practically no ornament. (Page 399.) (Compare Pl. LXXXII, fig. 5.)

Fig. 8.—Outline of the whorl-section.

Fig. 9.—Suture-line showing asymmetry of *L.*

The specimens of the last two species were lately obtained from Stoke Knap (Whaddon Hill), near Beaminster, Dorset, by Mr. E. Wilson, F.G.S., who has kindly allowed me to add them to my cabinet.

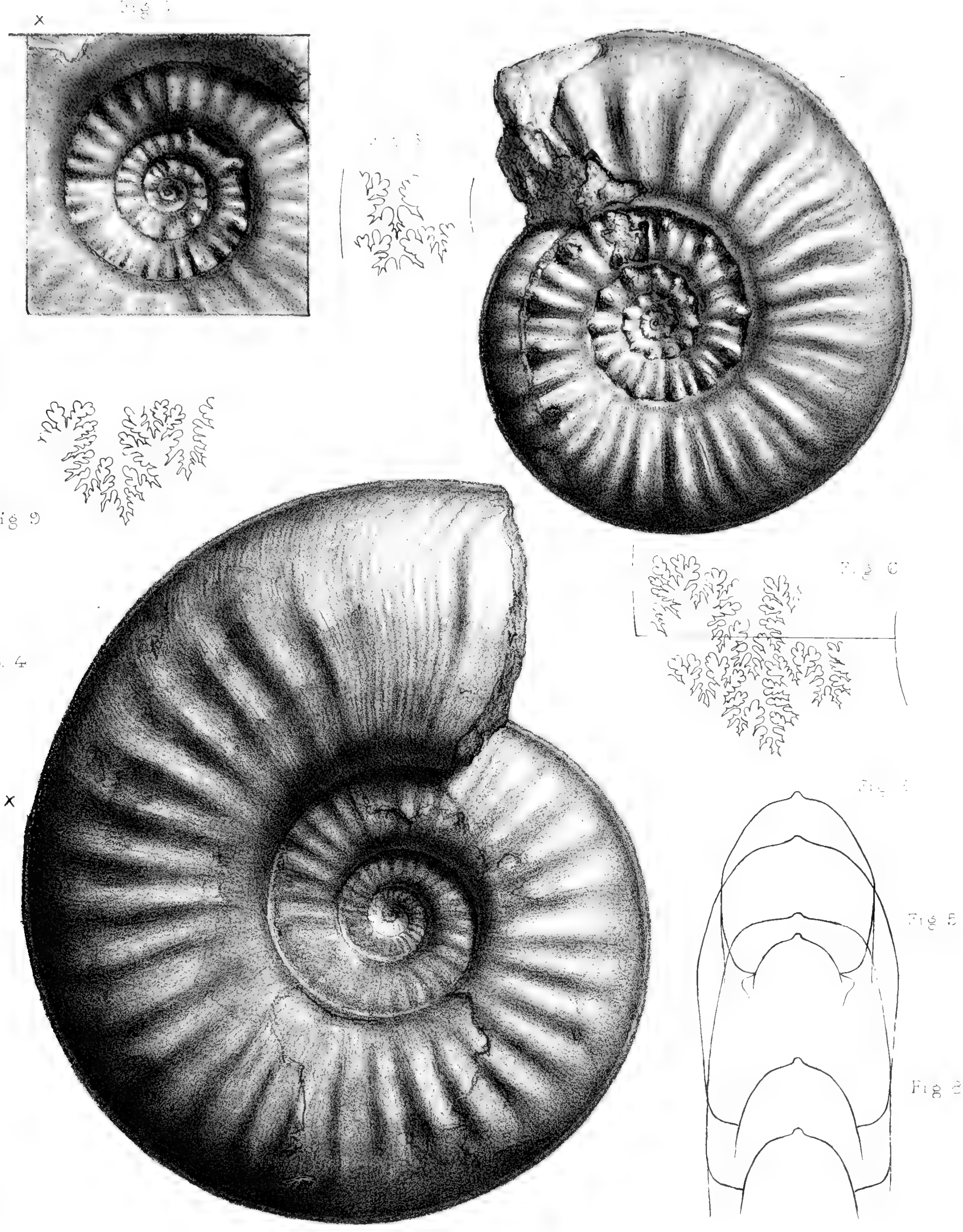


Fig 9

Fig. 4

Fig 6

Fig 5

Fig 8

F.H.Michael del.et lith.

Mintern Bros imp

PLATE CII.

Concavum-zone.

Figs. 1—3.—Sonninia costigera, *S. Buckman.*

Fig. 1.—Side view of an adult example reduced to three-fourths of natural size. (The central whorls are badly preserved and damaged by the tool.) In order to show the characters of the specimen some details have been taken from the other side to supplement this view. The umbilicus is drawn slightly too large so far as its ultimate and penultimate turns are concerned. Bradford Abbas. My Collection. (Page 428.)

Fig. 2.—Outline of the whorl-section reduced to three-quarters of natural size.

Fig. 3.—Portion of the suture-line from the same fossil, showing an axial but anisosceloid terminal lobule to *L.*

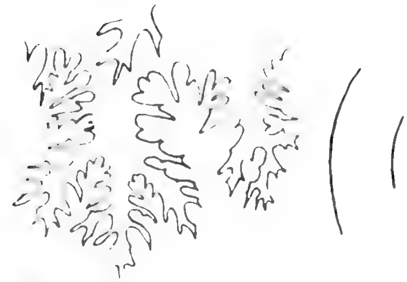
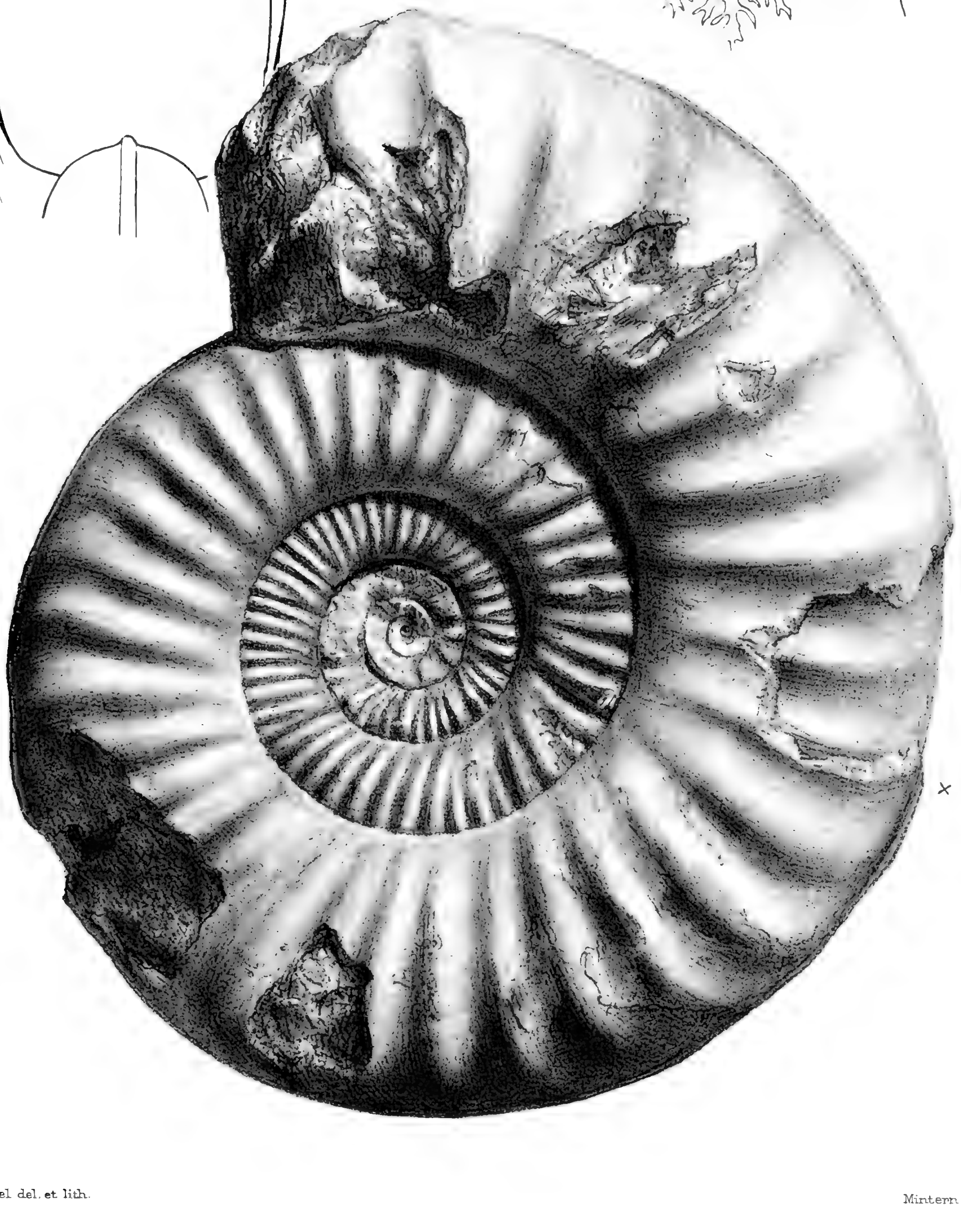


Fig. 1



F. H. Michael del. et lith.

Mintern Bros imp.

PLATE CIII.

Fig. 1.—ZURCHERIA INCONSTANS, *S. Buckman.*

Fig. 1.—A more precise delineation of part of the suture-line of the specimen depicted in Pl. L, figs. 4, 5, to replace fig. 7 of that plate, showing that *L* has a terminal lobule ecto-brachysceles. (Compare Pl. L, fig. 10.) (Page 297.)

Fig. 2.—ZURCHERIA PARVISPINATA, *S. Buckman.*

Fig. 2.—The superior lateral lobe of the specimen illustrated in Pl. XLIX, figs. 18—20, showing a distinctly ecto-brachysceles terminal lobule. (Page 296.)

Fig. 3.—SONNINIA MULTISPINATA, *S. Buckman.*

Fig. 3.—Parts of the septal outlines of the specimen drawn in Pl. L, figs. 11—13, showing that the superior lateral lobes are not identical on both sides. That on the left side (the fossil held with the truncation towards the eye, the right in the figure) has the terminal lobule ultra-axial and ecto-brachysceles; that on the right side (left in figure) has this lobule intra-axial and endo-brachysceles. (The circles mark the positions of spines.) (Page 425.)

Fig. 4.—SONNINIA LOCUPLES, *S. Buckman.*

Fig. 4.—Suture-line of the specimen depicted in Pl. L, figs. 16—18, to supplement fig. 18. (Page 431.)

Fig. 5.—SONNINIA MODESTA, *S. Buckman*, var.

Fig. 5.—Suture-line of the specimen depicted in Pl. LXVIII. (Page 422.)

Fig. 6.—SONNINIA SUBCOSTATA, *S. Buckman.*

Fig. 6.—Suture-line of the type-specimen depicted in Pl. LXXI, figs. 4, 5. (Page 330.)

Fig. 7.—SONNINIA ALTERNATA, *S. Buckman.*

Fig. 7.—A more complete delineation of the suture-line of the type-specimen shown in Pl. LXXVII, figs. 3—5, to supplement fig. 5. (Page 424.)

Fig. 8.—SONNINIA DIVERSA, *S. Buckman.*

Fig. 8.—Suture-line of the type-specimen drawn in Pl. LXXXIII, figs. 1, 2. (Page 399.)

Fig. 9.—SONNINIA LÆVIGATA, *S. Buckman.*

Fig. 9.—The superior lateral lobe of the specimen illustrated in Pl. LXXXII, figs. 5, 6—a somewhat imperfect sketch owing to manner of fossilisation. (Page 399.)

Fig. 10.—SONNINIA NUDA, *S. Buckman.*

Fig. 10.—Suture-line of the type-specimen shown in Pl. LXXXII, figs. 3, 4. (Page 402.)

Fig. 11.—SONNINIA SIMPLEX, *S. Buckman.*

Fig. 11.—Suture-line of the type-specimen drawn in Pl. LXX, figs. 2, 3. (The "fig. 2" has been omitted in the lettering; it is the right-hand bottom figure.) (Page 423.)

Figs. 12, 13.—SONNINIA SUBSTRIATA, *S. Buckman.*

Fig. 12.—Suture-line of a specimen from Stoke Knap, near Beaminster. Collected by Mr. E. Wilson. Now in my cabinet. (Page 406.)

Fig. 13.—A somewhat imperfect sketch of the superior lateral lobe of the type-specimen, Pl. LXXI, figs. 6, 7.

Fig. 14.—SONNINIA DOMINICA, *S. Buckman.*

Fig. 14.—A more precise delineation of the suture-line of the specimen figured in Pl. LXIX, figs. 1—3, under the name *Sonn. dominans,* to replace fig. 3. (The explanation of the plate should be corrected to *Sonn. dominica.*) (Page 410.)

Fig. 15.—SONNINIA SEMISPINATA, *S. Buckman.*

Fig. 15.—Parts of the suture-line of the type-specimen illustrated in Pl. LXXVII, figs. 1, 2. (Page 416.)

Fig. 16.—SONNINIA BIPLICATA β.

Fig. 16.—The suture-line of the specimen depicted in Pl. LXXVIII, figs. 4, 5. (Page 417.)

Fig. 17.—SONNINIA CRASSIBULLATA, *S. Buckman.*

Fig. 17.—Suture-line of the type-specimen drawn in Pl. LXXX, figs. 1, 2. (Page 400.)

Fig. 18.—SONNINIA CRASSICOSTATA, *S. Buckman.*

Fig. 18.—The superior lateral lobe of the type-specimen (Pl. LXXX, figs. 4, 5), showing an unusual character, the terminal lobule being ecto-brachysceles. (Page 398.)

Fig. 19.—SONNINIA, sp.

Fig. 19.—Portions of the septal outlines of a specimen allied to *Sonninia subsimplex,* but more ornately lobate. (See page 440.) This is a copy of a photograph.

Fig. 20.—SONNINIA, sp.

Fig. 20.—Portions of the septal outlines of the specimen figured in Pl. LXVII, figs. 3—5, to supplement fig. 5. This specimen is allied to the *renovata-* and *dominans-*series. (See page 438.)

Fig. 21.—SONNINIA RECLINANS, *S. Buckman.*

Fig. 21.—Septa of the specimen figured in Pl. LXV, figs. 3, 4, as *Sonn. crassispinata,* which should now be altered. (Page 421.)

Fig. 22.—SONNINIA PARVICOSTATA, *S. Buckman.*

Fig. 22.—Superior lateral lobe of the type-specimen illustrated in Pl. LXXV, figs. 3, 4. (Page 396.)

Fig. 23.—SONNINIA SPINOSA, *S. Buckman.*

Fig. 23.—Suture-line of the specimen mentioned at page 365, showing *L* with an axial terminal lobule practically isosceloid. (Page 394.)

Fig. 24.—SONNINIA *aff.* DOMINANS, *S. Buckman.*

Fig. 24.—Part of the septal outline of the specimen figured in Pl. LXVII, figs. 1, 2. (Page 438.)

(It should be noted that to facilitate comparison all suture-lines in this plate and in the other parts of the work have [except through oversight] been placed with the peripheral portion to the left hand. This has necessitated the reversing of some of the tracings.)

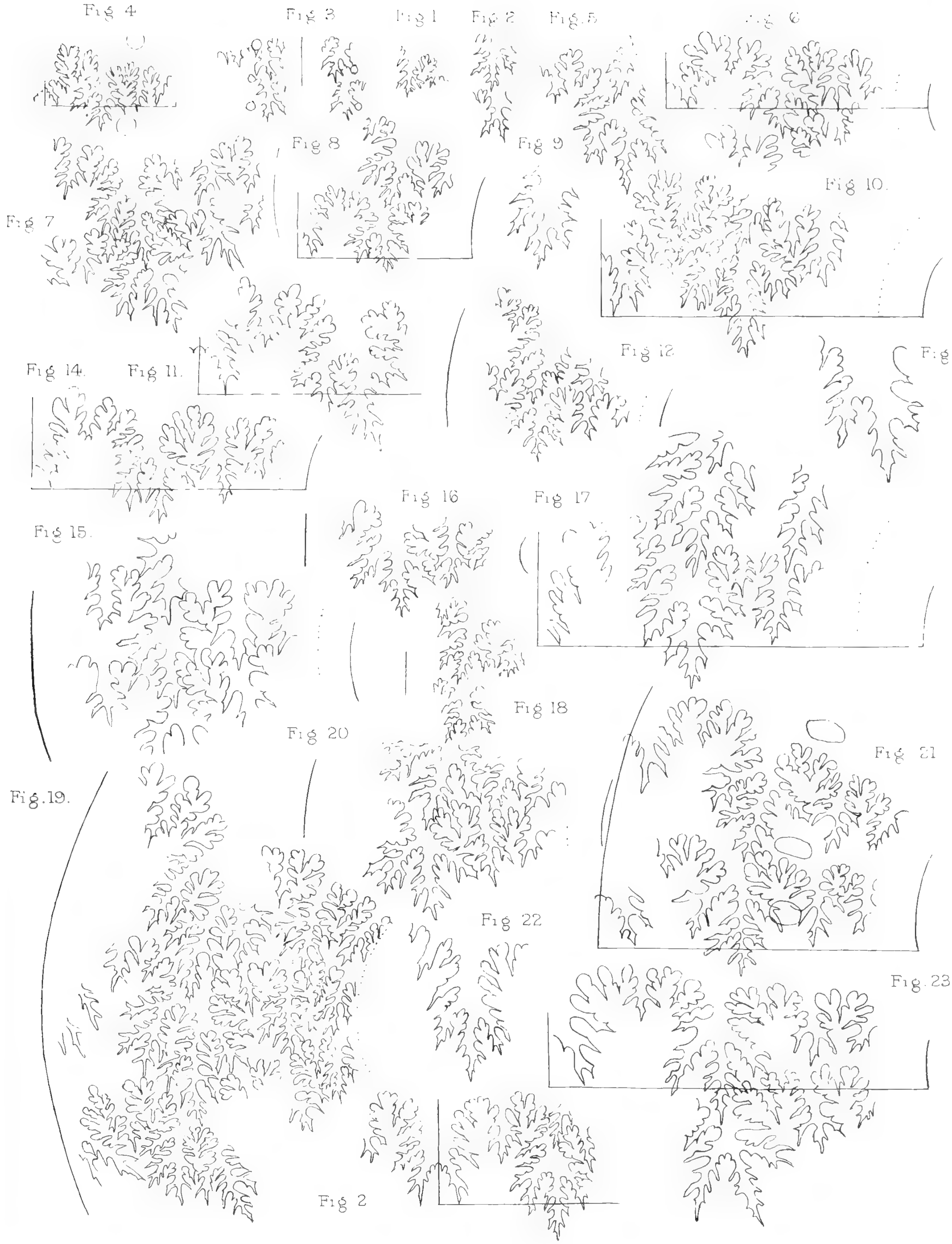


Fig 4
Fig 3
Fig 1
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Fig. 5
Fig 6
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Fig 9
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Fig 10.
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Fig 11.
Fig 16
Fig 17
Fig 15.
Fig 18
Fig 20
Fig 21
Fig. 19.
Fig 22
Fig. 23
Fig 2

THE

PALÆONTOGRAPHICAL SOCIETY.

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MDCCCXCIV.

A MONOGRAPH

OF

THE FISHES

OF THE

OLD RED SANDSTONE OF BRITAIN.

BY

RAMSAY H. TRAQUAIR, M.D., LL.D., F.R.S.,

KEEPER OF THE NATURAL HISTORY COLLECTIONS IN THE MUSEUM OF SCIENCE AND ART, EDINBURGH.

Part II, No. 1.—THE ASTEROLEPIDÆ.

Pages 63—90; Plates XV—XVIII.

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THE FISHES

OF THE

OLD RED SANDSTONE OF BRITAIN.

Part II.—THE ASTEROLEPIDÆ.

INTRODUCTION.

Every beginner in geology is familiar with the general aspect of *Pterichthys.* Figures of it, unfortunately for the most part antiquated, are to be found in every text-book; and with its box-like body, oar-like "arms," and scaly tail, it still holds its own in popular teaching as one of the most bizarre in shape of all the creatures whose remains have come down to us from the so-called "Age of Fishes;" while to the scientific worker its relationship to other forms, fossil or recent, has always seemed to be of the most enigmatical description, though it has also given origin to many curious speculations.

Pterichthys, discovered by Hugh Miller at Cromarty about the year 1831, and first figured and described by him in his 'Old Red Sandstone' in 1841, the name having been given by Agassiz, is not the only genus of the group to which it belongs. Disjointed remains of a closely allied form from the Devonian of Russia were described by Eichwald in 1840, under the name of *Asterolepis,* from which genus is now derived the designation of the entire family. Another genus described by the same author, also from fragmentary Russian material, is *Bothriolepis,* which after much confusion and misunderstanding at length occupies its place as a very distinctly marked member of the group. To these, a few years ago, I added a fourth, the little *Microbrachius* from the Old Red of John o' Groat's, originally collected by the late Mr. C. W. Peach. Whether any other named genera can claim a position in or near the Asterolepidæ is a question which may best be discussed in the sequel.

The remains of these creatures being in many cases extremely fragmentary, their nomenclature is, as might be expected, often cumbered with a complicated

synonymy. Different parts of the same species have been described as different genera, while in other cases remains of fishes having no affinity with them have been mixed up and confounded with those of true Asterolepidæ.

As regards the affinities of the group, which have furnished much food for theory, it will, I think, be wiser to postpone the consideration of this interesting subject until the descriptive part of the work has been accomplished. I propose, therefore, in the first place, to go through the British members of the family, genus by genus and species by species, and then in a concluding chapter to discuss the limits of the family, and to enter into the probable relationship of the Asterolepidæ to other fossil forms, and to fishes in general. Meanwhile the well-known facts, that their dermal plates are composed of true bone, that they had a well-developed lateral sense-canal system on the body and head, and that *Pterichthys* at least possessed a tail covered with scales, and provided with a dorsal fin, and a genuinely piscine heterocercal caudal, furnish pretty conclusive evidence that the Asterolepidæ were actual fishes, and that they were not specially related either to Ascidians, Crustaceans, or Arachnids.

In pursuing my studies on these and other fishes of the Devonian epoch I have of course largely drawn my material from the rich collections in the Edinburgh Museum of Science and Art; but I have also availed myself of the privilege of examining the magnificent series in the British Museum, presided over by Dr. Woodward, F.R.S., Keeper, and Mr. A. Smith Woodward, F.L.S., Assistant Keeper of the Geological Department, to whom for their kindness and courtesy my best thanks are due. Of exceeding value is also the collection of Old Red Sandstone fishes in the Museum of Practical Geology, Jermyn Street, London, in consulting which I have always met with the most friendly reception from Sir A. Geikie, F.R.S., and Mr. E. T. Newton, F.R.S. My thanks are also due to Professor McKenny Hughes, F.R.S., of Cambridge, Professor Green, F.R.S., of Oxford, Professor Boyd Dawkins, F.R.S., and Mr. W. E. Hoyle, of Manchester, as well as to the authorities of the museums at Elgin and at Forres, for the ready access which they have always afforded me to the collections under their charge. To other sources of material and of information, and to other friends who have generously assisted me, I shall have frequent occasion in the course of the following descriptions to make my grateful acknowledgments.—R. H. T.

Terminology of the Asterolepidæ.

Before entering into the description of individual forms, it is first of all necessary to understand the general structure of an Asterolepid, and to know the names by which the various parts found in a fossil state may be distinguished. For this

Fig. 34.

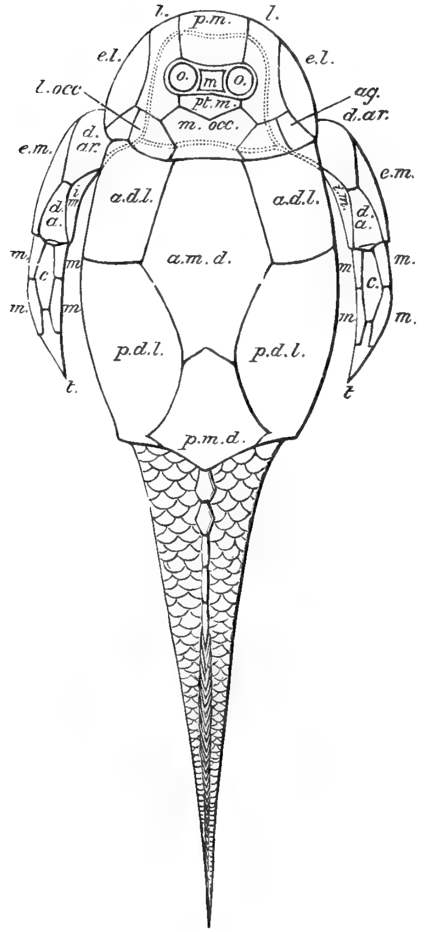


Fig. 35.

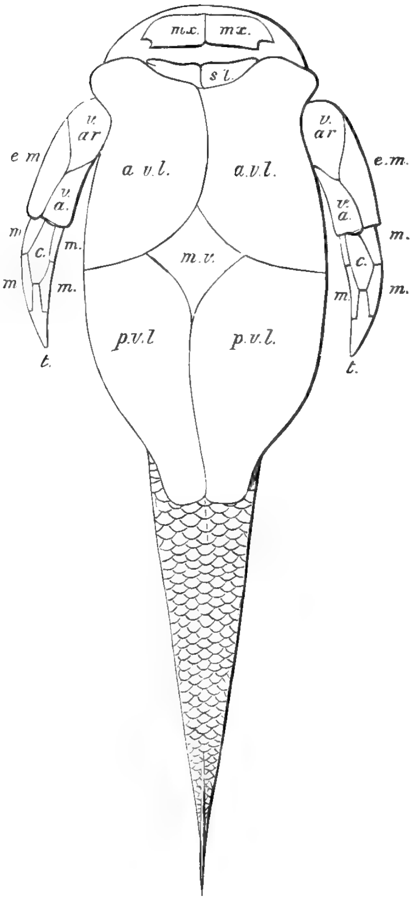


Fig. 36.

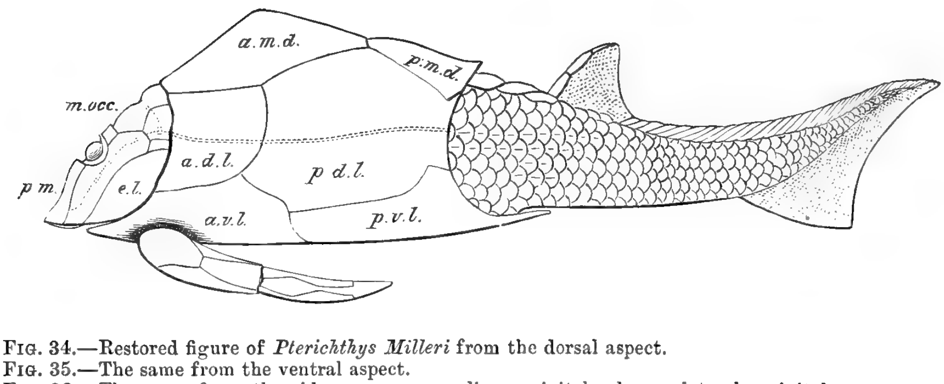


Fig. 34.—Restored figure of *Pterichthys Milleri* from the dorsal aspect.
Fig. 35.—The same from the ventral aspect.
Fig. 36.—The same from the side. *m. occ.*, median occipital; *l. occ.*, lateral occipital; *ag.*, angular; *pt.m.*, post-median; *p.m.*, pre-median; *l.*, lateral; *e. l.*, extra-lateral; *m.*, median; *o.*, ocular; *mx.*, maxilla; *s. l.*, semilunar; *a. m. d.*, anterior median dorsal; *p. m. d.*, posterior median dorsal; *a. d. l.*, anterior dorso-lateral; *p. d. l.*, posterior dorso-lateral; *a. v. l.*, anterior ventro-lateral; *p. v. l.*, posterior ventro-lateral; *m. v.*, median ventral; *d. ar.*, dorsal articular; *v. ar.*, ventral articular; *e. m.*, external marginal; *i. m.*, internal marginal; *d. a.*, dorsal anconeal; *v. a.*, ventral anconeal; *c. c.*, centrals of lower limb; *m. m. m. m.*, marginals of lower limb; *t.*, terminal of lower limb.

purpose it is as well to take *Pterichthys*, as being the genus best known in its entirety, if not in every matter of detail.

The nomenclature of the parts here employed is essentially the same as that used in my essay "On the Structure and Classification of the Asterolepidæ," published in 1888.[1]

The body or carapace consists of osseous plates closely fitted together, closed above, below, and at the sides, but open in front for the head, and behind for the tail. The head is represented almost entirely by a dorsal shield, formed also of plates united by suture. The two pectoral limbs or "arms" consist also of plates similarly united, and are hollow tubes like the legs of an insect so far as their remains preserved in the stone are concerned.

The head-shield is semicircular, or rather semi-elliptical in shape, rounded in front and truncated behind, where it joins the body-carapace. In the centre it shows a transverse opening, the *median* opening or *orbit*, slightly contracted in the middle and expanded at each of its rounded sides. This opening is in perfect specimens filled up by at least three other plates, which, being loose, are usually lost. Of these one is in the centre, quadrate in shape, but with concave outer margins, and may be called the *median* or *pineal* plate (*m.*), as it shows on the internal aspect a shallow rounded pit, pointed out by Mr. Smith Woodward as probably the impression of the pineal body. This is by its outer concave margins in contact on each side with a rounded convex *ocular* plate (*o.*), indicating certainly the position of the eye, but whether or not due to an ossification in the sclerotic is doubtful. The nuchal region is occupied by a large plate, the *median occipital* (*m. occ.*), shaped somewhat like the conventional royal "crown," but without the pinnacle in the centre. In front of this and immediately behind the median opening is a smaller plate, the *post-median* (*pt. m.*); while between the anterior margin of that opening and the front of the cranial shield is one of larger size and somewhat quadrate shape, the *pre-median* (*p. m.*). Two large paired pieces, the *lateral* plates (*l.*), one on each side, bound the median opening laterally, and also extend to the front of the shield, behind which, and forming part of the hinder margin of the buckler external to the median occipital, are two other paired plates, the *lateral occipital* (*l. occ.*) and the *angular* (*ag.*).

The upper and lateral aspect of the cranial shield is now completed by a plate on each side, which is only loosely articulated in *Asterolepis* and *Pterichthys*, though firmly sutured in *Bothriolepis*. This is the *extra-lateral* (*e. l.*) or *opercular* plate, as it has also been called by some writers.

Pander has represented in *Asterolepis*, somewhat hypothetically, a narrow plate, the so-called *os terminale*, forming the very anterior margin of the shield in

[1] 'Ann. and Mag. Nat. Hist.' (6), vol. ii, pp. 485—503; see also Smith Woodward's 'Catalogue of the Fossil Fishes in the British Museum,' pt. 2, pp. 208—212.

front of the pre-median and lateral pieces, but of whose existence in *Pterichthys* at least I have never been able to see any evidence. I shall return to this question under *Asterolepis*.

On the lower aspect of the head and close behind the anterior margin of the shield are two transversely oblong plates (*m. x.*), right and left, the position of which was first determined by Whiteaves in *Bothriolepis*,[1] an observation corroborated by Smith Woodward.[2] These plates must have been situated in front of the mouth, and may therefore be lettered, at least conventionally, as *maxillæ*. There can be no doubt that they were similarly placed in *Pterichthys*, though I formerly assigned to them, as *mental* plates,[3] a position behind the mouth, and in *Asterolepis* they were designated *maxillæ inferiores* by Pander. Close to the postero-external angle of each of these plates there is a rounded notch, considered by Smith Woodward in *Bothriolepis* as possibly indicating a nasal opening.[4]

The body-carapace is box-like, nearly quite flat below and vaulted above. It is composed of thirteen plates, of which three are median and ten paired, and these are united to each other by overlapping sutures, a marginal band along the internal surface of the overlapping plate being excavated to fit on to a correspondingly excavated band along the margin of the outer surface of the plate overlapped.

On the upper surface we see the *anterior* and *posterior median dorsal* plates (*a. m. d.* and *p. m. d.*) succeeding each other in the middle line and on each side; passing down also on the lateral wall are the *anterior* and *posterior dorso-laterals* (*a. d. l.* and *p. d. l*). On the under surface, and also taking part in the formation of the lateral wall, are two pairs of plates, the *anterior* and *posterior ventro-lateral* (*a. v. l.* and *p. v. l.*), of which the anterior requires special attention, as to it the pectoral limb is articulated. Near the anterior extremity of this plate, on the outer aspect and close above the angle which separated the lateral from the ventral surface, is a shallow excavation, from the bottom of which rises a peculiar process (*b. p.*, woodcuts, Figs. 38 and 39, p. 78) resembling a thick-walled cup or helmet, whose hollowed-out "mouth" points outwards, and also somewhat backwards and downwards, the cup itself being fixed by a stout ridge which traverses the containing hollow from behind forwards and also slightly downwards. This may be called the *brachial process* (helmet-process of Pander), as it is grasped by the two articular plates of the upper arm, and thus forms the brachial joint. Immediately behind this brachial process is a small oval aperture, the *brachial foramen* (*fr.*, woodcut, Fig. 39), perforating the brachial fossa from the interior, and which no doubt served to convey to the arm the blood-vessels and nerves required for its supply.

[1] 'Trans. Roy. Soc. Canada,' vol. iv, sect. iv, 1887, pp. 103, 104.

[2] 'Geol. Mag.,' (3), vol. ix, 1892, p. 484.

[3] Loc. cit., p. 488.

[4] This notch is somewhat differently placed in *Bothriolepis*, being fair on the outer margin of the plate instead of at its postero-external angle.

The ventral surface of the carapace is completed by the *median ventral* plate (*m. v.*, woodcut, Fig. 35) in the centre, and in front by two very small *semilunar* plates (*s. l.*), each of which occupies a space cut out from the inner half of the anterior margin of the anterior ventro-lateral, and is in contact in the middle line with its fellow of the opposite side. In *Bothriolepis* these last-mentioned plates seem to be represented by a single median one.

It must be noticed (woodcut, Fig. 35) that the ventral wall of the carapace passes further forwards than the dorsal one; it extends, indeed, so far under the cranial shield that the space for the mouth between the semilunar plates behind and the maxillary plates in front is extremely narrow,—so narrow that I was thereby originally led into placing the two pairs of plates in apposition. In fact, in more than one specimen in the Edinburgh Museum they actually do seem to be in apposition.

Each of the hollow *arms* or *brachia* is divided by a transverse *elbow-joint* into two segments, proximal and distal. The proximal segment or *upper arm* is trigonal in transverse section, getting more flattened towards the elbow, and shows three surfaces, a dorsal slightly convex, a ventral flat, and a somewhat concave internal one, the latter fitting on to the side of the carapace when the arm is flexed. The proximal extremity of the arm is formed by two *articular* plates (*d. ar.* and *v. ar.*), dorsal and ventral, whose rounded and hollowed proximal expansions grasp between them the brachial cup-like process of the anterior ventro-lateral plate of the body. These plates are consequently not in apposition at the joint, but are separated by an interval or slit, which contains and moves on the ridge attaching the brachial cup to the bottom of its fossa, and this interval is closed internally by the internal articular plate, and externally by the upper narrow extremity of the external marginal.[1] The internal articular plate (*i. ar.*), placed right on the inner surface of the arm below the joint, is not seen in these figures, though it is represented in *Asterolepis* in Pl. XVIII, fig. 6; its free upper margin is concave, forming a rounded notch, over which the nerves and nutrient vessels of the arm must have passed. The *external marginal* (*e. m.*) forms the whole of the outer border of the upper arm, and has nearly opposite to it the smaller internal marginal (*i. m.*), while dorsally and ventrally this part of the limb is completed by the dorsal and ventral *anconeal* pieces (*d. a.* and *v. a.*).

The shape of the proximal end of the arm formed by the articular plates strongly reminds us of the upper extremity of a mammalian humerus, and the arrangement resembles outwardly a ball-and-socket joint. But the direction of the strong ridge which supports the brachial cup, and which closely fits the slit between the articular plates, necessarily restricts the movement to one of flexion

[1] In *Bothriolepis*, however, the slit is completed externally by the two articular plates coming together above the external marginal.

and extension in a plane which is nearly horizontal, and the extent of which is from a position parallel and close to the side of the body to one at right angles to it.

The distal portion of the limb, or *lower arm*, is more flattened, and shows a dorsal and ventral surface, two sharp margins, external and internal, and a sharp apex or point. It is composed of two *central* pieces (*c.*), one dorsal and one ventral, four marginals (*m.*), two external and two internal, and one terminal (*t.*).

The *elbow-joint* is somewhat complicated. Each upper marginal of the lower arm is furnished above with an articular process, which is received within the lower extremities of the internal and external marginal plates respectively of the upper part of the limb. Then, on the other hand, each anconeal plate, dorsal and ventral, of the upper arm has a small flat articular process below, which fits into a slit on the outer surface of the upper extremity of the corresponding upper central of the lower arm. It is hard to say how much movement could have been here allowed, but from the form of the joint I should fancy it was limited to a slight flexion and extension, and possibly only in the horizontal plane, as in the case of the shoulder.

The tail is covered with small, rounded, slightly imbricating osseous scales, which are arranged in longitudinal rows, and also in transverse bands. On the dorsal aspect behind the carapace there is a small median fin. Along the dorsal margin the scales are different in shape from those on the sides: in front of the fin they are in the form of a few narrow longitudinal median plates; behind it they are elongated and imbricating, like the fulcra or V-scales along the body prolongation of the tail of a Palæoniscid fish. The dorsal fin is triangular, acuminate, and covered with small scales, no distinct "rays" being seen; and along its anterior margin some prominent elongated scales are placed, producing an appearance which has been mistaken for a spine. The hinder extremity of the fish is formed by a completely heterocercal caudal fin, the body axis curving upwards as a pointed and slightly arched prolongation, and giving origin below to a fin-expanse which is triangular in form, or slightly excavated behind, but not bilobate. In my previous restoration of *Pterichthys* I omitted this fin, not having seen it at the time, though I found it shortly afterwards in a specimen from Tynet in the Manchester Museum. Meanwhile Mr. Smith Woodward discovered evidence of it in a specimen in the British Museum, which he has figured in Part II of his valuable 'Catalogue.'

On the body and head there was a well-marked *lateral sense-canal* system, indicated by grooves on the external surfaces of certain of the osseous plates, which grooves have often been mistaken for sutures, especially those on the cranial shield. On each side the lateral groove passes from behind forwards over the posterior and anterior dorso-lateral plates, and thence on to the external occipital, where it at once bifurcates, a transverse branch passing across the median occipital to join its fellow of the opposite side. The main groove then runs forwards on the

lateral cranial plate, and arriving in front of the median opening it bends inwards to join the opposite groove on the pre-median plate; a slightly different arrangement, however, is seen in *Bothriolepis*, as we shall see when that genus comes to be specially considered.

Classification of the Asterolepidæ.

The *family* of Asterolepidæ may be briefly defined as follows:

Head and body covered with osseous plates which are externally sculptured and ganoid, those of the body firmly sutured into a hollow carapace. Eyes approximate, contained in a transverse median orbit, and separated by a loose interocular median plate. Position of the nasal organs not definitely known. One pair of limbs, pectoral, oar- or sword-like, each consisting of many osseous plates enclosing a central tubular hollow, and articulated to the side of the body immediately behind the head. A well-developed lateral sense-canal system. Tail, where known, covered with bony scales, and provided with one dorsal and a completely heterocercal caudal fin.

The relative fineness or coarseness of the external sculpture is not constant in plates belonging to the same species, for as a rule the ornament is finer in younger, coarser in older individuals.[1]

Four genera—*Asterolepis* Eichwald, *Pterichthys* Agassiz, *Bothriolepis* Eichwald, and *Microbrachius* Traquair—may with certainty be reckoned to this family, and all occur in British Devonian (Old Red Sandstone) rocks. They are broadly distinguished from each other by the mode of overlapping of the anterior median dorsal plate and the relative length of the arms; hence the tabulation adopted by Mr. Smith Woodward in his 'Catalogue,' and which may here be quoted:

I. Pectoral appendages shorter than the body-armour.
  1. Anterior median dorsal plate overlapping (both) the dorso-laterals . *Asterolepis.*
  2. Anterior median dorsal plate overlapping the anterior dorso-lateral, overlapped by the posterior dorso-lateral . . . *Pterichthys.*
  3. Anterior median dorsal plate in front overlapping and behind overlapped by the anterior dorso-lateral and the posterior dorso-lateral . *Microbrachius.*

II. Pectoral appendages longer than the body-armour.
  4. Anterior median dorsal plate overlapping the anterior dorso-lateral, overlapped by the posterior dorso-lateral . . . *Bothriolepis.*

Of these genera *Asterolepis* and *Pterichthys* resemble each other very closely; *Bothriolepis* is in many points of detail considerably different from either; while the structure of *Microbrachius* is unfortunately as yet incompletely known.

[1] R. H. Traquair, 'Proc. Roy. Phys. Soc. Edinb.,' vol. xi, 1892, p. 285.

ASTEROLEPIS, *Eichwald*, 1840.

CHELONICHTHYS, *Agassiz*.
ODONTACANTHUS, *Agassiz*.
COCCOSTEUS, *Agassiz* (pars).
(?) ACTINOLEPIS, *Agassiz*.
(?) NARCODES, *Agassiz*.

Generic Characters.—Median dorsal plate overlapping both the anterior and posterior dorso-lateral plates. Arms shorter than the body-carapace; articular plates of the upper arm scarcely meeting externally over the external marginal. Post-median plate of the head large and broad, excluding the median occipital from the margin of the orbit; pre-median plate notched in front; extra-lateral plate loosely articulated with the rest of the cranial shield. External ornament of plates consisting of raised tubercles with stellate bases, which may be sometimes confluent. Lateral line system on the head connected by two commissures, a posterior one crossing the hinder part of the median occipital, and an anterior crossing the pre-median plate in front of the orbit. Tail unknown.

So far as is known, the characters of *Asterolepis* do not differ essentially from those of *Pterichthys* except in the mode of articulation of the anterior median dorsal plate, which in the latter genus is overlapped by the posterior dorso-lateral. The tail is, however, unknown, owing to the disjointed condition in which its remains have hitherto only occurred.

History.—English readers who are acquainted only with popular works on Geology and Palæontology may be surprised to find that the *Asterolepis* here described is not the "*Asterolepis* of Stromness," which in the middle of the century attained celebrity through the writings of Hugh Miller. The latter is a huge Coccostean, referable to the genus *Homosteus* of Asmuss, and having no affinity to the original *Asterolepis* of Eichwald, which must retain its name by the inexorable law of priority. That such a state of confusion came to exist in the nomenclature of these fishes was entirely due to a mistake on the part of Agassiz, a mistake which was for long years implicitly accepted in this country, owing to the overwhelming authority of his name.

The genus *Asterolepis* was established by Eichwald in 1840[1] for certain isolated plates from the Devonian of Russia, which proved to belong to an animal closely allied to if not generically identical with that to which, from Scottish specimens of entire fishes, Agassiz had about the same time given the name of *Pterichthys*, but which was first described and figured by Hugh Miller a year later,[2] though the

[1] "Die Thier- und Pflanzen-reste des alten rothen Sandsteins und Bergkalks im Novgorodschen Gouvernement," 'Bull. Soc. St.-Pétersbourg,' April, 1840.

[2] 'The Old Red Sandstone, or New Walks in an Old Field,' Edinburgh, 1841, pp. 49—53, pls. i and ii.

name without description had been announced by Sir R. I. Murchison to the British Association at its meeting at Glasgow in August, 1840.[1]

To the Russian remains Agassiz gave somewhat later the name *Chelonichthys*,[2] a name which he, however, afterwards withdrew[3] in favour of Eichwald's *Asterolepis*, to which priority was due. But unfortunately he also identified generically with Eichwald's *Asterolepis* certain other remains from the Devonian strata of Dorpat, some of which were first figured by Kutorga as *Trionyx* and *Ichthyosauroides*,[4] and of which a considerable number, collected by Asmuss, were reproduced in plaster and copies sent to Agassiz, who figured a number of them as bones of "*Asterolepis*."[5] Now some of these were generically identical with the creature of whose bones and buckler many specimens from Thurso, collected by Robert Dick, came into the possession of Hugh Miller, and thus it came to pass that the writer of the 'Footprints' figured these remains as belonging to *Asterolepis*, a genus to which they had no resemblance save in the stellate tuberculation of the external surface.

That *Asterolepis*, Eichwald, was closely allied to *Pterichthys*, and had nothing to do with any of the Dorpat bones represented by Asmuss's casts, is unconsciously shown by Agassiz himself, inasmuch as he figured as *Asterolepis ornata*, Eichwald, a median occipital plate of unmistakably Pterichthyan character,[6] apparently quite unaware of the significance of its shape. Nevertheless, in some controversial remarks[7] into which he entered with Eichwald on the subject, he insisted that his *Chelonichthys* (= *Asterolepis*, Eichw.) had nothing to do with *Pterichthys*.

In 1857 Pander published his classic work 'Ueber die Placodermen des devonischen Systems," in which, from isolated and beautifully uncompressed and solid plates from Livonia, he skilfully reconstructed and minutely described the *Asterolepis ornata* of Eichwald. Going also extensively into the synonymy of the subject, he cited no less than eighteen other named genera as identical with *Asterolepis* in whole or in part. These were—

Bothriolepis, *Eichw.*	Pamphractus, *Agass.*
Chelonichthys, *Agass.*	Homothorax, *Agass.*
Glyptosteus, *Agass.*	Placothorax, *Agass.*
Pterichthys, *Agass.*	Odontacanthus, *Agass.*

1 'Brit. Assoc. Rep.,' x, 1840, Trans. Sect., p. 99.

2 'Poissons fossiles,' vol. i, 1884, p. xxxiii (name only).

3 'Poiss. foss. vieux Grès rouge,' 1845, p. 89.

4 'Beitrag zur Geognosie und Paläontologie Dorpats,' St. Petersburg. 1835—37.

5 'Poiss. foss. vieux gr. rouge,' pl. xxxii.

6 Ibid., pl. xxx, figs. 5, 6. The other fragments figured on the same plate as *Asterolepis ornata* (figs. 2—4, 7—9) in all probability belong also to the same creature.

7 Ibid., Appendix, p. 151; in reply to remarks by Eichwald in 'Karsten's Archiv,' vol. xix, 1845, p. 667.

CTENOPTYCHIUS, *Agass.* (*partim*).	PSAMMOSTEUS ?, *Agass.*
NARCODES, *Agass.*	CTENACANTHUS, *Agass.* (*partim*).
COSMACANTHUS, *Agass.*	CHEIROLEPIS ?, *Eichw.*, non *Agass.*
PLACOSTEUS ?, *Agass.*	MICROLEPIS ?, *Eichw.*
PSAMMOLEPIS ?, *Agass.*	CHELYOPHORUS, *Agass.* (*partim*).

But though Pander did great service here by pointing out some strange mistakes into which Agassiz had fallen by giving new generic names to fragments which he did not understand, subsequent research has shown that two of the genera contained in the above list, namely, *Bothriolepis* and *Pterichthys*, though belonging to the same family, are nevertheless maintainable as distinct from *Asterolepis;* while some others, queried, it is true, by Pander himself, are not even referable to the Asterolepidæ. An analysis of the table according to the present state of knowledge may, therefore, be interesting.

To *Asterolepis* may be referred, besides *Chelonichthys*, which was withdrawn by Agassiz himself, *Odontacanthus*, *Narcodes.* Agassiz also transferred his *Ctenoptychius crenatus* to "*Odontacanthus.*" As to *Chelyophorus*, one of Agassiz's species, *C. pustulatus*, seems to belong to *Asterolepis* (= *A. concatenata*, Eichwald).

Bothriolepis, Eichw., is maintainable as a good genus, and with it are certainly synonymous *Pamphractus*, *Homothorax*, *Placothorax*,—possibly also *Cosmacanthus*, though this is a most undeterminable fragment. *Glyptosteus* was withdrawn by Agassiz himself in favour of *Bothriolepis.*

Pterichthys, Agass., though very close to *Asterolepis*, is nevertheless retainable as distinct.

Psammosteus, Agass. (including *Placosteus* and *Psammolepis*, names withdrawn by Agassiz), has nothing to do with the Asterolepidæ, and the plates here included are probably Selachian. To a similar category belongs *Ctenacanthus serrulatus*, Agass., which Mr. Smith Woodward quotes as a synonym of *Psammosteus mæandrinus.* With regard to Eichwald's *Microlepis,* and the species *splendens* and *unilateralis*, which he referred to *Cheirolepis,* they were considered by Agassiz as well as Pander to be referable to *Psammosteus.* By Mr. Smith Woodward they are designated as "indeterminable."

Of course if *Asterolepis* were identical with, or even allied to *Pterichthys*, the name could no longer be applied to Hugh Miller's large fish from Orkney and Caithness, which was correctly assigned by Pander to Asmuss's genus *Homosteus,* after being duly deprived of the "teeth of *Dendrodus* and the scales of *Glyptolepis*," with which Miller, misled by Agassiz, who classed "*Asterolepis*" among his "Cœlacanthi," had mistakenly endowed it.

Naturally Pander's views did not meet with immediate acceptance in this country, where people were loth to abandon or change names for British fossils

which had become current through the writings of such distinguished men as Agassiz and Hugh Miller. They were fiercely combated by Sir Philip Grey-Egerton in the following words:—"Having read both sides of the question with great care, my own impression is that Prof. Eichwald may perhaps have included in his genus *Asterolepis* some fragments which he subsequently ascertained (through the more perfect Scotch specimens sent to Russia by Dr. Hamel) to belong to the genus *Pterichthys* of Agassiz, and hence discarding the majority, namely, *Asterolepis* proper, assigns this name to the minority, to the exclusion of the Agassizian name. In the meantime Prof. Agassiz, then engaged upon his 'Poissons fossiles du vieux Grès rouge,' received through Prof. Bronn, from Eichwald himself, specimens of his *Asterolepis* which had no reference to *Pterichthys*, but were identical with the genus *Chelonichthys* established upon specimens brought over from Russia by Sir Roderick Murchison, and of which other specimens were found in the Orkney beds. On making this discovery he at once relinquished his own name *Chelonichthys*, and adopted *Asterolepis* of Eichwald. If now it is sought to supersede *Pterichthys* of Agassiz by *Asterolepis* of Eichwald, it is surely just that the term *Chelonichthys* should be retained for Eichwald's *rejectamenta*, rather than *Homosteus* of Asmuss, a name of much later date than that of Agassiz."[1]

Most unfortunately, however, for his contention, Sir Philip here overlooked the crucial fact mentioned above, and which was specially insisted on by Pander, namely, that Agassiz himself figured as *Asterolepis ornata* of Eichwald a head-plate which, far from having "no reference to *Pterichthys*," is the median occipital if not of *Pterichthys*, then of a very closely allied form indeed. So far, therefore, as the "*Asterolepis* of Stromness" is concerned his argument falls to the ground.

Had Pander succeeded in establishing the absolute identity of *Pterichthys* with *Asterolepis*, the former name would certainly have had to be be cancelled in favour of the latter. But, as we shall see more fully further on, a ground of distinction between the genera was sought to be established by Beyrich,[2] Lahusen,[3] and Zittel[4] on the supposed articulation of the arms of *Pterichthys* to a special pair of plates (*thoracic*, Egerton; *ceinture thoracique* + *plaques articulaires*, Agass.), which plates certainly do not exist in *Asterolepis*, in which Pander showed that these appendages were directly articulated to the anterior ventro-lateral. But in 1888[5] I proved the non-existence of these "thoracic" plates in *Pterichthys*, and showed that its pectoral limbs were articulated precisely as in *Asterolepis*, while at the same time I drew attention to a character which seems quite sufficient to

[1] 'Quart. Journ. Geol. Soc.,' vol. xvi, 1859, p. 122.

[2] 'Zeitschr. deutsch. geol. Gesellsch.,' 1877, p. 754.

[3] 'Trans. Imp. Min. Soc., St. Petersburg,' vol. xv, 1880, p. .

[4] 'Handbuch der Palaeontologie,' vol. iii, pt. i, pp. 153—157.

[5] 'Geol. Mag.' (3), vol. v, p. 508.

maintain the distinction of the two genera. This distinction lies in the mode of articulation of the anterior median dorsal plate, which in *Asterolepis ornata* is stated by Pander to overlap both anterior and posterior dorso-laterals, while in *Pterichthys* it overlaps the anterior and is overlapped by the posterior of these plates. The former mode of articulation I found extremely well marked in a large Asterolepid, the *Coccosteus maximus* of Agassiz from the Upper Old Red of Nairn, and which I have since found to approach the Russian *A. ornata* in other, if more trivial characters, more closely than it does the species referable to *Pterichthys*.

My views have been adopted by Smith Woodward in his ' Catalogue,' so that *Asterolepis* now stands out as a genus independent of *Pterichthys*, and represented in this country by one well-marked species, *A. maxima*, which I shall now proceed to describe.[1]

Asterolepis maxima, *Agassiz*, sp. Plates XV—XVIII.

1845. Coccosteus maximus, *Agassiz*. Poiss. foss. v. Grès rouge, p. 137, pl. xxx *a*, figs. 17, 18.
1848. Pterichthys major, *H. Miller* (non *Agassiz*). Quart. Journ. Geol. Soc., vol. iv, p. 311.
1857. Asterolepis, *Pander*. Placoderm. dev. Syst., p. 17.
1860. — ornata, *Eichwald* (*pars, in errore*). Leth. Rossica, vol. i, p. 1508.
1888. — maximus, *Traquair*. Geol. Mag. (3), vol. v, p. 568; and Ann. Mag. Nat. Hist. (6), vol. ii, p. 494, pl. xviii, figs. 1, 2.
1891. — maxima, *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, p. 206, pl. v, fig. 1.

Specific Characters.—Anterior median dorsal plate pointed-lanceolate in shape, the anterior margin being very narrow; obtusely carinated behind the middle. Surface ornament consisting of small, very closely set tubercles with stellate bases, rarely confluent, but sometimes arranged in rows, which are often concentric, sometimes radiating, more often tortuous. Carapace and head attaining a length of probably fourteen or fifteen inches in large specimens.

Mr. Smith Woodward says of this species that it attains more than twice the size of the Russian *A. ornata*, but I have seen plates and fragments which indicate that the latter occasionally grew to a size as great if not greater than

[1] References to various doubtful fragments which have been assigned to "Asterolepis" will be found in Mr. Smith Woodward's 'Catalogue,' pt. ii, p. 207. They are all foreign, with two exceptions, namely, *A. Malcolmsoni*, Ag., and *A. minor*, Ag., which are said to have occurred in the neighbourhood of Elgin (the latter also at Riga, in Russia), but without the original specimens it is quite impossible to form any opinion as to their nature.

that of its Scottish representative. Nor can I agree with him in calling the surface tubercles "large," at least in comparison with those of *A. ornata.*

Mr. Woodward also suggests by means of a ? the possible identity of Agassiz's *A. Malcolmsoni,* from Scat Craig, with the species under consideration; but judging from Agassiz's representation of the former I do not think that possible, and unfortunately the original of that figure seems to be lost.

History.—The original specimen, collected by Dr. Malcolmson in Nairnshire, and now in the Museum of the Geological Society of London, was figured by Agassiz as *Coccosteus maximus,* and considered by him to be a median ventral plate.[1] It was, however, rightly interpreted by Pander as a median dorsal of *Asterolepis,* in the extended sense in which he used this term; while Hugh Miller, too, alluding to Agassiz's figure, says, "From its appearance I would be more inclined to regard it as the hexagonal dorsal plate of *Pterichthys major.*"

"*Pterichthys major*" was, indeed, up till very lately used as a very convenient term by collectors wherewith to designate indiscriminately every fish-plate of any size occurring in the Scottish Upper Old Red Sandstone, and as "*Pterichthys major*" I found these Nairnshire plates universally known, when I took up their study in 1888. I very speedily found, however, that they represented a very different creature from the *Pterichthys* (*Bothriolepis*) *major* of the adjoining district of Elgin, and that its nearest ally was the *Asterolepis ornata* of the Russian Devonian. Since then I have, by assiduously collecting at Nairn every summer, brought together an important series of its remains, which has furnished the material for the following description.

Geological Position and Locality.—Only in the Upper Old Red Sandstone of the immediate vicinity of Nairn, as at Seabank and Kingsteps Quarries. The original specimen is said to have come from Boghole. It is remarkable that while *Asterolepis maxima* is unknown in those strata round Elgin which are characterised by *Bothriolepis major,* not a single remnant of any species of *Bothriolepis* has ever been found in the *Asterolepis*-bearing beds at Nairn. Other fish-remains are very rare in these beds, but such as I have obtained lead me to suspect that we have here to deal with quite a different fauna from that of the closely adjoining district of Elgin; it remains, however, for the Geological Survey to settle the stratigraphical relationship of the beds.

Special Description of Asterolepis maxima.

General Form.—Several specimens showing the form and proportions of the body have occurred, of which the largest and best, unfortunately wanting the arms, is

[1] This is in all probability the same plate as that to which in 1838 Dr. Malcolmson applied the MS. name, *Cephalaspis Gordonii,* see 'Quart. Journ. Geol. Soc.,' vol. xv, 1859, p. 344.

represented in Pl. XV. In this figure, which is one-fifth smaller than the original, we see the internal surface of the whole dorsal part of the carapace along with the cranial shield, the latter being slightly injured on the left side. The general form of the animal as well as the arrangement of its plates is also exhibited in the accompanying restored sketches, in which nothing is hypothetical unless indicated by dotted lines.

The carapace is flat below; its narrow sides are nearly vertical; the back slopes gently downwards and outwards on each side, the middle line behind the centre of the anterior median dorsal plate, being distinctly carinated. Seen from the side, the back is gently arched antero-posteriorly, but at the nape the profile of the head sinks down at an angle of 45° to the horizontal plane. The general shape of the head and body thus agrees pretty well with that in *Pterichthys*, though much more depressed. When the arms are flexed by the side the elbow-joint does not quite reach the junction between the anterior and posterior ventro-lateral plates, nor does the apex of the lower arm quite attain to the middle of the last-named body-plate.

Head.—A large head, *minus* the extra-lateral plates, is represented in Pl. XVII, fig. 1. Unfortunately a large patch of bone is in this specimen broken out behind the orbit, but the detail here lost is supplied in woodcut, Fig. 37, p. 78, from other specimens.

The median occipital plate (*m. occ.*) may be described as having seven sides or margins,—one posterior, projecting backwards in a rounded angle, and showing a narrow smooth band overlapped by the anterior median dorsal and the two anterior dorso-laterals; two lateral, sloping gently outwards and forwards, articulating with the external occipital; two antero-lateral, sloping again inwards and articulating with the lateral plate of each side; and two anterior, which now sloping inwards and backwards form with each other a re-entering angle, which receives the post-median plate in front. The *external occipital* (*e. occ.*) is trapezoidal and shows four sides,—one posterior, articulating with the anterior dorso-lateral; one internal, articulating with the median occipital; one anterior, articulating with the lateral piece (*l.*); and one external, articulating with the angular. The last (*ag.*) is a very small plate, somewhat oblong in shape, and forms the postero-external angle of the shield. In front of the median occipital, and forming the posterior margin of the orbit, is the *post-median* (*pt. m.*), which, irregularly pentagonal, shows one long anterior and slightly convex orbital margin; two short lateral margins, articulating with the lateral plate on each side; and two longer postero-lateral ones, which, meeting at an obtuse angle behind, fit into the anterior indentation of the median occipital.

Each lateral plate (*l.*) is of a complicated shape, and consequently difficult to describe, but roughly speaking it may be said to have four margins. The very

irregular inner one articulates with the median occipital and post-median behind, then it shows about the middle a wide rounded notch, which forms the external boundary of the orbit, in front of which it articulates with the pre-median (*p. m.*);

FIG. 37.

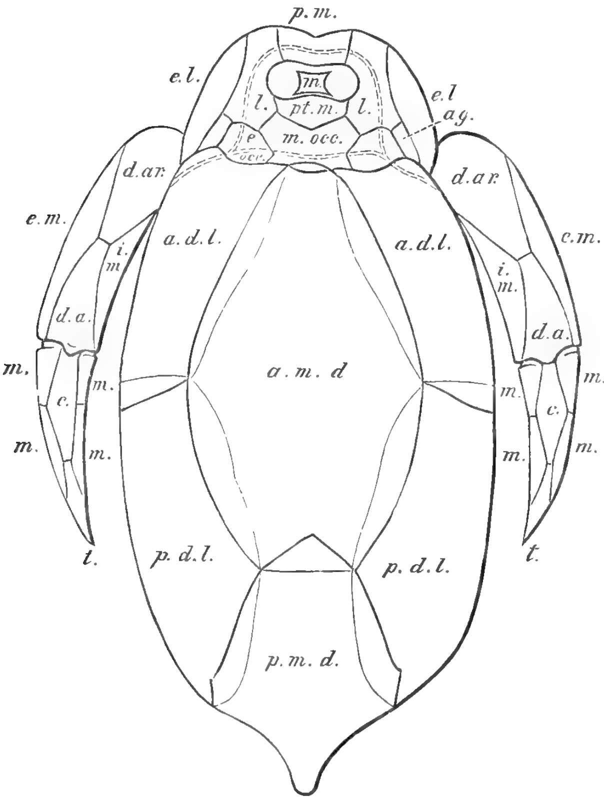


FIG. 38.

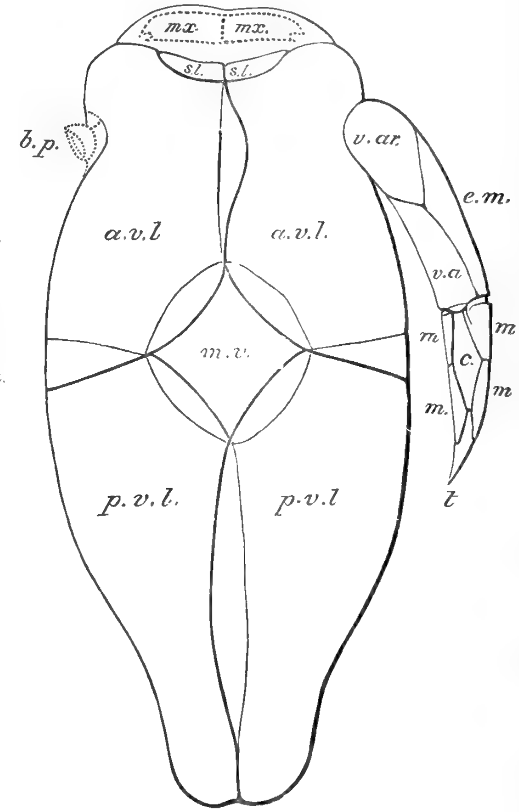


FIG. 39.

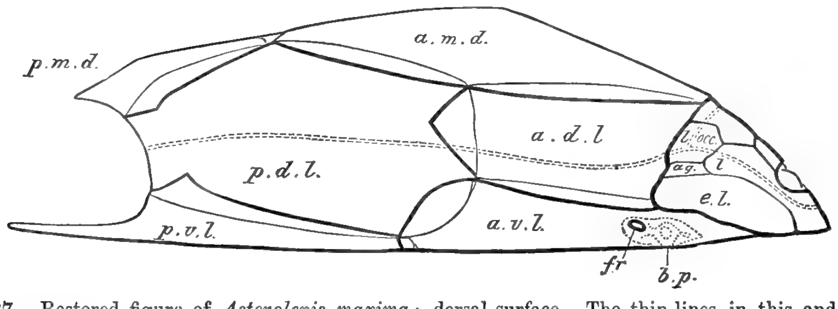


FIG. 37.—Restored figure of *Asterolepis maxima;* dorsal surface. The thin lines in this and Figs. 35 and 36 represent the edges of the plates which are overlapped, and therefore concealed. Lettering as in Figs. 34, 35, and 36.

FIG. 38.—Restored figure of *Asterolepis maxima*, ventral surface.

FIG. 39.—Restored figure of *Asterolepis maxima*, lateral view, the arm supposed to be removed. *b. p.*, brachial process; *fr.*, brachial foramen. In this figure, by a mistake, the anterior dorso-lateral plate is represented as overlapping the anterior ventro-lateral instead of the converse arrangement.

its outer margin, slightly concave, articulates with the extra-lateral, the posterior one with the external occipital and angular, while the still shorter anterior margin forms part of the front of the cranial shield. Between the two laterals in front is the

pre-median, a large four-sided plate, which behind forms the anterior boundary of the orbit, while its anterior margin, showing a tolerably conspicuous median indentation or re-entering angle, forms the middle part of the front of the shield.

Two matters of detail, in which both the pre-median and the lateral plates participate, must now be described. It will be noticed (Pl. XVII, fig. 1) that the anterior margin of the cranial shield formed by these two plates is distinctly bevelled off by a narrow unsculptured band, which suggests the idea of some additional plate having been once here articulated. So it is also in *Asterolepis ornata*, as described by Pander, who in his figures fits on to this place a narrow transverse plate, his "*os terminale*" ('Placodermen,' pl. vi, fig. 1, No. 2). This bone Pander admits that he had never procured perfect from Livonia, but thought that he had found it *in situ* in Scottish examples of *Pterichthys* (ibid., pl. vi, fig. 5). Nevertheless, on comparing the figure here quoted with numerous specimens of *Pterichthys*, I am satisfied that the suture there indicated as marking off the *os terminale* is only the transverse groove belonging to the lateral line system which crosses the front of the band, so that I do not believe in the existence of an "*os terminale*" in that genus (see above, p. 66). Indeed I can see no absolute necessity in *Asterolepis* that an additional bone should here have been articulated, as the same appearance might have been produced by the margin of the shield in front of the sculptured surface having been covered with soft skin.

Then it must be observed that both in the lateral and pre-median the part of the bone next the orbit is thickened, and produced downwards and inwards at the sides, downwards and backwards in front, so as to furnish the orbit with anterior and lateral walls, and to some extent also with a floor, thus converting it from a mere opening into a cavity,—widely open, however, posteriorly. An idea of this arrangement may be got by inspection of fig. 8 on Pl. XVIII, representing an impression of the outer surface of a cranial shield from which all the bone has been removed; and this consequently exhibits in the middle a prominent cast of the orbital cavity, which is, however, slightly injured on the right side. This is extremely interesting when compared with the condition of the orbit in *Cephalaspis*, which appears to be floored below in a manner still more complete.

Roofing over the middle of the orbital cavity is placed the *median* or pineal plate (*m.*), a transversely oblong piece, with lateral margins concavely excavated to complete each eye-circle. I have not seen in any specimen any trace of the ocular plates, or of the additional median piece discovered by Whiteaves in *Bothriolepis*.

The last piece in connection with the head which has been found in *Asterolepis maxima* is the *extra-lateral* or so-called opercular plate (*e. l.*). It is seen in the specimen figured on Pl. XV; but, owing to its loose articulation to the side of the shield, is invariably wanting in detached heads. It differs from that in *Pterichthys*

by being more antero-posteriorly oblong in shape, and having the articular notch on its inner side rather more forward in position. This inner margin is affixed to the outer aspect of the lateral and angular plates, while the outer edge rests on the prolongation of the anterior ventro-lateral plate of the body in front of the brachial articulation, the cleft between them having probably functioned as a gill-opening.

The *maxillary* plates of *Asterolepis maxima* are still unknown.

The course of the sensory grooves on the head has been indicated in the definition of the genus, and is so clearly exhibited in fig. 1, Pl. XVII, as to require no further description.

Body-Carapace.—The *anterior median dorsal* plate (Pl. XVI, fig. 1) is somewhat lanceolate or pointed-elliptical in contour, the sides being convex and the anterior margin very short,—indeed, less than half the width of the posterior. The upper surface is gently convex in front, but decidedly carinated behind the middle; and at the posterior extremity there is a depressed triangular articular area, whose base is formed by the whole of the hinder margin of the plate, and which is covered by the pointed anterior extremity of the posterior median dorsal. No other articular surface is seen on the dorsal aspect, but on looking at the plate from below (woodcut, Fig. 40) the anterior margin is seen to be excavated for overlapping the median occipital of the head, while along the right and left margins two narrow

FIG. 40.

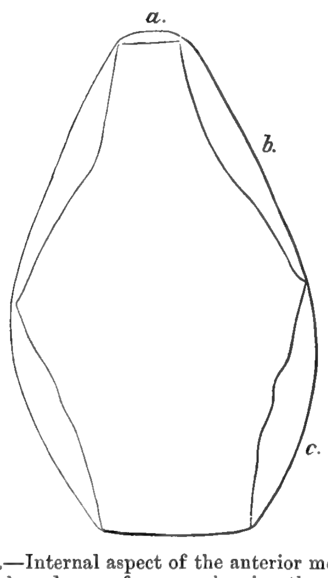


FIG. 41.

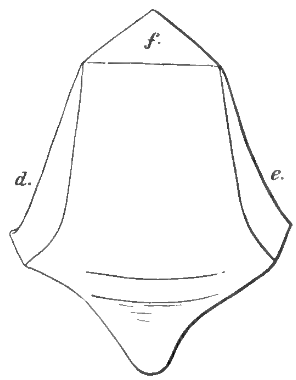


FIG. 40.—Internal aspect of the anterior median dorsal plate. *a.*, surface in front overlapping the median occipital; *b.* and *c.*, surfaces overlapping the anterior and posterior dorso-lateral plates respectively.
FIG. 41.—Internal aspect of the posterior median dorsal plate restored. *d.* and *e.*, surfaces overlapping the right and left dorso-lateral plates respectively; *f.*, surface overlapping the anterior median dorsal.

bands, anterior and posterior, are excavated to overlap the corresponding margins of the anterior and posterior dorso-lateral plates.

The *posterior median dorsal* plate (Pl. XVI, fig. 2; woodcut, Fig. 41) somewhat

reminds us in its shape of the conventional "spade" on playing cards. Above, it is carinated like the hinder part of the plate in front, but shows no articular surface whatever. Its broad free posterior aspect terminates the upper part of the carapace behind, and forms a conspicuous backwardly directed, pointed projection; the longer lateral margins slope gently inwards as well as forwards, joining at obtuse angles the short straight antero-lateral ones, which, uniting in front, form the sharply pointed apex of the plate. On the under aspect (woodcut, Fig. 41) a conspicuous rounded ridge connects the postero-external angles across the base of the posterior pointed process, in front of which three marginal articular surfaces are seen. Two of these (*d.* and *e.*) lie along the lateral margins, one on each side, and overlap the posterior dorso-lateral plates; while the third (*f.*), anterior and median, lies just at the apex, where it forms a broad-based isosceles triangle, which fits over the corresponding area noticed at the posterior extremity of the superficial aspect of the anterior median dorsal.

The *anterior dorso-lateral* (Pl. XVI, fig. 3; and woodcuts, Figs. 42 and 43) is oblong-pentagonal, and shows five margins,—an anterior, a superior, an inferior, a postero-superior, and a postero-inferior. Of these five the anterior is oblique

FIG. 42.

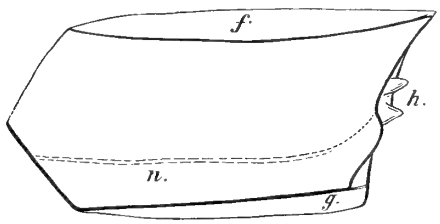


FIG. 43.

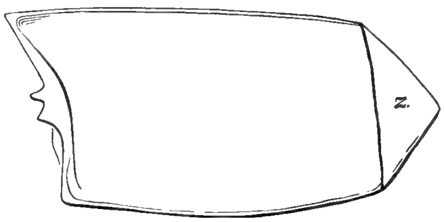


FIG. 42.—Restored sketch of superficial aspect of right anterior dorso-lateral plate. *f.*, articular surface along the upper margin for the anterior median dorsal; *g.*, surface along the lower margin for the anterior ventro-lateral; *h.*, processes for articulation with the external occipital; *n.*, lateral line groove.

FIG. 43.—Deep surface of right anterior ventro-lateral plate. *z.*, surface for articulation with the posterior dorso-lateral plate.

when the plate is looked at detached from the body, and forms an acute angle with the upper and an obtuse one with the lower margins; the upper and lower, of which the upper is the longer, are nearly straight, or only slightly convex; while the considerably shorter postero-superior and postero-inferior margins meet each other in a backwardly directed angle, which is nearly a right one. On the superficial aspect two elongated articular areæ are seen, one (*f.*) along the upper margin, over which the anterior part of the outer edge of the anterior median dorsal fits; the other (*g.*) lies along the inferior margin, and is overlapped by the anterior ventro-lateral; lastly, traversing the surface of the plate from before backwards at the junction of its lower and middle thirds, is the lateral sensory groove (*n.*).

Turning now to the concave inner surface of the plate, we find posteriorly a

broad triangular area (*z.*) which fits on to a similar one on the surface of the posterior ventro-lateral. Then we observe that the anterior margin, which overlaps with a thin edge the posterior border of the cranial shield, sends inwards a sort of ledge, on the anterior surface of which are two diverging ridges or processes (*h.*), which fit *below* the external occipital, so that the joint between this plate and the head is of a very complicated character.

The *posterior dorso-lateral* (Pl. XVI, fig. 4; woodcut, Fig. 44) is of an irregularly oblong shape, and shows six sides,—superior, inferior, postero-superior, postero-

FIG. 44.

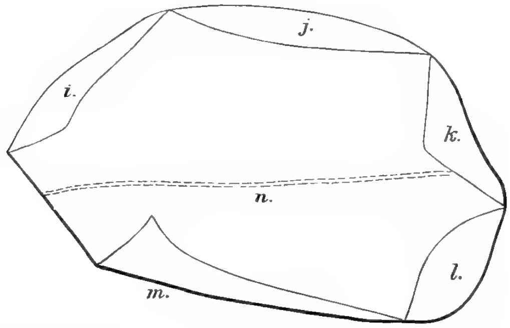


FIG. 44.—Sketch of the outer aspect of the right posterior dorso-lateral plate. *i.*, articular surface for the posterior median dorsal; *j.*, for the anterior median dorsal; *k.*, for the anterior dorso-lateral; *l.*, for the anterior ventro-lateral; *m.*, for the posterior ventro-lateral; *n.*, lateral groove.

inferior, antero-superior, and anterior. Of these the postero-inferior is free, and forms the lateral boundary of the caudal opening of the carapace.

The external surface presents a longitudinal lateral line groove (*n.*), which must be placed horizontally in holding the plate in its natural position; and five articular surfaces, one along each margin except the postero-inferior, so that this plate, though overlapped by five others, itself overlaps none. The narrow surface (*i.*) along the postero-superior margin is for the posterior median dorsal plate; that along the upper margin (*j.*) receives the corresponding posterior facet of the outer margin of the anterior median dorsal. Above and in front, the third articular space (*k.*) is in the form of an obtuse-angled triangle, whose broad base is formed by the postero-superior margin of the plate, and whose apex is directed backwards; and this is overlapped by the posterior extremity of the anterior dorso-lateral. A fourth broad articular space (*l.*), overlapped by the anterior ventro-lateral plate, corresponds with the antero-inferior margin; while the fifth (*m.*) lying along the inferior edge, and covered by the posterior ventro-lateral plate, is narrow, and, though angularly expanded behind, tapers to a point anteriorly.

The inner surface of the plate is hollowed and smooth, and of course presents no articular areæ. Close to the posterior extremity a low, broad, rounded ridge passes nearly vertically upwards, corresponding in position to the angular

expansion of the articular surface on the outside for the posterior ventro-lateral, and extending to the level of the lateral line groove.

The *anterior ventro-lateral* plate, of the deep surface of which a natural cast is shown in Pl. XVII, figs. 3 and 4, is of a peculiar oblong shape, and consists of two parts; one broad and horizontal, taking part in the flat ventral wall of the carapace, and another vertical, rising from its outer margin at a right angle, and contributing to the lateral wall. Near the front of this ascending lamina the arm-joint is situated.

Taking the horizontal part first, it may be described as having four margins. The narrow anterior one is rounded off externally, while from its mesial half a narrow crescentic space is cut out for the semilunar (*s. l.*, woodcuts, Figs. 45 and 46). The inner margin is tolerably straight, or slightly convex, and is much shorter than the external one, as the posterior border of the plate, somewhat convex mesially, runs obliquely backwards and outwards to the postero-external angle. The external margin shows near the front a shallow inflexion at the brachial articulation, and then proceeds backwards with a gently convex contour.

Only on the bone of the *left* side (leaving the brachial joint out of consideration) is an articular area to be observed on the outer surface, and that is along the internal margin (*o.*), which is overlapped by the corresponding plate of the other (right) side of the body. The latter, the *right anterior ventro-lateral*, has consequently no area on its superficial aspect, as it is overlapped by no other plate.

Fig. 45.

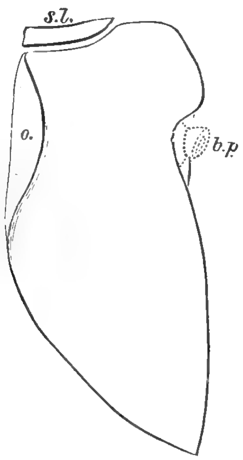


Fig. 46.

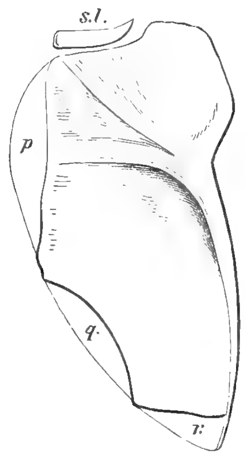


Fig. 45.—Restored sketch of the ventral surface of the horizontal lamina of the left anterior ventro-lateral plate. *o.*, articular area for the plate of the opposite side; *b.p.*, brachial process; *s. l.*, semilunar plate.

Fig. 46.—Restored sketch of the deep or upper surface of the horizontal lamina of the right anterior ventro-lateral plate. *p.*, surface overlapping the plate of the opposite side. *q.*, surface overlapping the median ventral; *r.*, surface overlapping the posterior ventro-lateral.

The vertical lamina, shown as an impression of the deep surface in Pl. XVII, fig. 4, rises gradually up from the front, where it is *nil*, backwards, till at the

commencement of the posterior fourth of the entire length it descends more suddenly to the posterior angle, its height at the place where it falls away being nearly equal to one-half of the breadth of the ventral lamina of the plate. On the outside aspect there are no areæ for articulation of other body-plates, but near the front, about the junction of the first and second fourths of the length of the plate, is found the brachial fossa, with its foramen (*fr.*, fig. 39) and its cup-like brachial or articular process. The latter unfortunately cannot be figured in the present species, as it is impossible to free it from the matrix. Broken surfaces, however, indicate that it was configured as in the Russian *A. ornata*.

The deep surface of the horizontal lamina shown in impression in Pl. XVII, fig. 3, and restored in woodcut, Fig. 46, shows two blunt ridges, which diverge at an acute angle from a point just in front of the brachial foramen, and of these one, the feebler of the two, passes transversely across to meet its fellow on the bone of the other side; the other, rather more strongly marked, passes inwards and forwards, and ends on the angle between the inner and anterior margins. On the very oblique posterior margin of the plate is seen first an area (woodcut, Fig. 46, *q.*) which overlaps the median ventral; behind and external to which, and also passing somewhat round on to the vertical lamina, is another (*r.*), overlapping the posterior ventral lateral. In addition to these the plate of the *right* side shows a narrow area (*p.*) along the inner margin, which overlaps the corresponding margin of its fellow of the opposite side.

On its internal surface the vertical lamina shows in front the brachial perforation (*fr.*), and along its upper margin a narrow articular band for the anterior dorso-lateral plate, this commencing just above the situation of the foramen. The oblique posterior margin of this lamina shows also a tolerably broad articular area, overlapping the posterior dorso-lateral plate, and also a small part of that which overlaps the posterior ventro-lateral. Those details are seen in impression on the natural cast represented in Pl. XVII, fig. 4.

The *semilunar* plates (*s.l.*, woodcuts, Fig. 45 and 46) form together the middle part of the anterior margin of the ventral wall of the carapace. Each of them is small, narrow, and transversely elongated, with a slightly concave free anterior margin, a short inner one apposed to its fellow of the opposite side, while the posterior and outer margins, in contact with the anterior ventro-lateral plate, pass with a curve uninterruptedly into each other. They thus fill up the corresponding narrow space cut out from the inner half of the anterior margin of the ventro-lateral.

The *posterior ventro-lateral* plate, like the anterior, takes part in the formation both of the ventral and lateral walls of the carapace, and its ventral lamina (woodcuts, Figs. 47—50) is also unsymmetrical on the two sides of the body, only in this case it is the left plate which overlaps the right. The ventral lamina

of the left plate (Pl. XVII, figs. 5 and 6 in impression, and woodcuts, Figs. 47 and 48 restored) shows a convex inner border, which in most cases passes by an almost uninterrupted curve round the front on to the antero-external angle; the

FIG. 47.

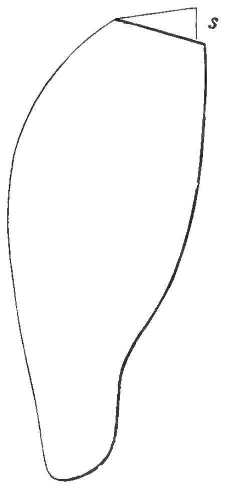


FIG. 48.

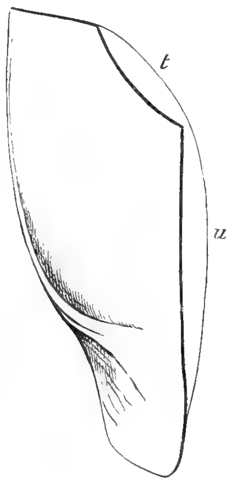


FIG. 49.

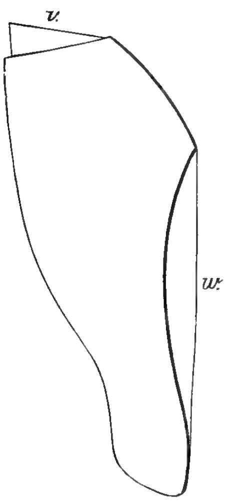


FIG. 50.

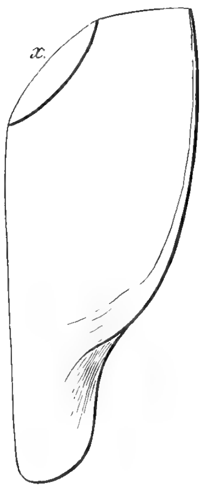


FIG. 47.—Superficial aspect of ventral lamina of left posterior ventro-lateral plate. *s.*, articular surface for anterior ventro-lateral.

FIG. 48.—Deep aspect of ventral lamina of left posterior ventro-lateral plate. *t.*, articular area for median ventral plate; *u.*, area for articulation with the posterior ventro-lateral of the opposite side.

FIG. 49.—Superficial aspect of ventral lamina of right posterior ventro-lateral. *v.*, surface covered by anterior ventro-lateral; *w.*, surface covered by the posterior ventro-lateral of the left side.

FIG. 50.—Deep aspect of the ventral lamina of the right posterior ventro-lateral plate. *x.*, articular area for overlapping the median ventral.

outer border is gently and elliptically convex as far as the commencement of the posterior fourth of the entire length, where it slightly alters its direction, forming a slight re-entering angle, and finally rounds off into the very short posterior border.

The ventral surface (woodcut, Fig. 47) shows only one articular surface (*s.*), that at the antero-external angle, which is overlapped by the anterior ventro-lateral plate. On its deep surface, however, we find two along the inner border; one anterior (woodcut, Fig. 48, *t.*), which overlaps the median ventral, and another longer one (*u.*) behind it, which fits over the plate of the opposite side.

The ascending lamina (Pl. XVII, fig. 6 in impression) is joined at nearly a right angle to the anterior three-fourths of the outer margin of the ventral portion of the plate. In front it is very low, but gradually rises posteriorly, until shortly before its termination its height is about equal to half the breadth of the ventral lamina; it then falls pretty suddenly away in the manner shown in the figure. This vertical lamina shows no articular area on its outer aspect, except a part of that one in front (*s.*) which is covered by the anterior ventro-lateral; but on its deep surface there is a long and narrow one along the upper margin, which tapers to a point in front, and covers the corresponding surface on the outside of the lower margin of the posterior dorso-lateral.

The *median ventral* plate (Pl. XVI, fig. 5, and Pl. XVII, fig. 2) is ovate lozenge-shaped, and shows on its ventral aspect four narrow articular areæ, two antero-external and two postero-external, which are confluent round the four angles, anterior, posterior, and right and left external, of the enclosed free central space. These areæ are overlapped by the corresponding right and left anterior and posterior ventro-lateral plates.

The articulations of these body-plates are absolutely constant, and they are so complicated that it may be as well to recapitulate them briefly.

The anterior median dorsal overlaps the anterior and posterior dorso-laterals, and is overlapped by the posterior median dorsal.

The posterior median dorsal overlaps the anterior median dorsal and the posterior dorso-laterals, but is itself overlapped by none.

The anterior dorso-lateral overlaps the posterior dorso-lateral, and is overlapped by the anterior median dorsal and the anterior ventro-lateral.

The posterior dorso-lateral overlaps no other plate, but is itself overlapped by the anterior and posterior median dorsals, by the anterior dorso-lateral, and by the anterior and posterior ventro-laterals.

The anterior ventro-lateral overlaps the anterior and posterior dorso-laterals, the posterior ventro-lateral, and the median ventral. The right plate overlaps, and the left one is overlapped by, its fellow of the opposite side.

The posterior ventro-lateral overlaps the median ventral and the posterior dorso-lateral, and is overlapped by the anterior ventro-lateral. The left plate overlaps, and the right one is overlapped by, its fellow of the opposite side.

The median ventral overlaps no other plate, but is overlapped by the two pairs of ventro-laterals.

The Pectoral Appendages or Arms.—It is largely through the study of casts and impressions like those figured in Pl. XVIII, figs. 1—3, that we attain to a knowledge of the structure of the arm in this species, as the bone structure is extremely friable, and has an obstinate tendency to adhere to the matrix rather with its external sculptured than with its internal smooth surface. However, the knowledge gained from such casts and impressions added to that afforded by others, like the portion of arm seen in Pl. XVIII, fig. 4, in which the bone is more or less retained, shows very clearly that in the configuration of its parts the pectoral limb of *Asterolepis maxima* is as near as possible to that of *A. ornata.*

The general form and structure of the Asterolepid arm, and the nomenclature of its plates having been already given at p. 68, it now remains to describe specially the parts as seen in the present species.

Upper Arm.—Each *articular* plate (*ar.*, woodcuts, Figs. 37 and 38) is rounded proximally and internally to form part of the articular " head " of the limb, while distally it is pointed. The two plates are related to each other and to the brachial process of the anterior ventro-lateral in the manner described at p. 68. As to their relations to other plates, there is some difference between the dorsal and the ventral articular. The former (*d. ar.*), which is longer than its fellow, articulates by its outer edge with the external marginal; by its truncated apex with the dorsal anconeal; by its inner margin with the internal articular and the internal marginal. The ventral articular (*v. ar.*) is likewise joined externally to the external marginal, but its apex being pointed its inner side articulates with the ventral anconeal and the internal articular, so that it does not touch the internal marginal at all.

The *internal articular* (*i. ar.*) is situated entirely on the inner aspect of the arm, and is therefore not seen either from above or below except in casts, where its impression is obliquely visible from the ventral aspect (Pl. XVIII, fig. 3). Its form is well seen on the portion of arm represented in fig. 6 of the same plate.

Its free upper margin is concavely excavated to form a shallow notch over which the nerves and nutrient vessels must have passed from the brachial foramen into the arm; its dorsal margin is obtusely angulated, and articulates with the dorsal articular and the internal marginal; its pointed apex is wedged in between the last-named plate and the ventral anconeal; its ventral margin, which is gently convex, articulates proximally with the ventral articular, distally with the ventral anconeal.

The *external marginal* (*e. m.*) extends the whole length of the outer side of the upper arm. It is narrow above and below, broad in the middle, and longitudinally folded upon itself along the margin of the limb, but not symmetrically, as the ventral portion is broader than the dorsal. Its pointed proximal extremity completes the slit between the two articulars externally (Pl. XVIII, fig. 5); its broader lower extremity receives within it the articular process of the upper

external marginal of the forearm; its dorsal and ventral reflected margins are each divided into two by an obtuse angle which is nearer the shoulder on the ventral than on the dorsal side, and above these angles on each side respectively the corresponding articular and anconeal plates are fitted.

The internal marginal (*i. m.*) is shorter than the external one. It is shaped somewhat like it, being narrow above and below and longitudinally folded on itself, but the line of the fold forms the dorso-internal margin of the limb, so that this plate does not appear at all on the ventral side, and only in internal casts (Pl. XVIII, fig. 3) can its impression be obliquely seen, when the cast is looked at from the ventral aspect. The two parts into which it is divided by the longitudinal fold are likewise unsymmetrical, as that seen on the dorsal surface of the limb is broader than the other which is placed on the inner aspect. The upper extremity of this plate is pointed; its lower one fits over the articular process of the upper internal marginal of the forearm; its convexly angulated dorsal margin articulates with the dorsal articular and the dorsal anconeal; while the corresponding ventral margin joins in like manner with the ventral articular and the ventral anconeal.

The *dorsal anconeal* (*d. a.*) is irregularly triangular, the base of the triangle being at the elbow-joint, while the truncated apex touches the distally directed and similarly truncated apex of the dorsal articular. The slightly convex outer margin is in contact with the external marginal. The inner, which is rather concave, articulates with the internal marginal; the lower, convex, and showing externally a narrow, smooth, articular surface, passes over the upper extremity of the corresponding upper central of the forearm, below which it is lodged in a slit on the outer surface.

The *ventral anconeal* (*v. a.*) is slightly different in shape. It is longer than the dorsal one, pointed above, and its surface is unequally divided by an angular longitudinal fold, the broader portion being ventral, the narrower internal in position, and in this way the ventral anconeal forms the inner margin of the ventral aspect of the limb below the ventral articular, and to the exclusion of the internal marginal. Its outer margin articulates with the ventral articular proximally, but for the greater part of its length with the external marginal; its inner margin articulates with the internal articular and internal marginal; and the part which its lower margin takes in the structure of the elbow-joint is similar to that described above in the case of the dorsal anconeal.

The Forearm.—The lower arm or forearm is flattened from above downwards, having two acute edges, external and internal; it is curved so that the outer edge is convex, the inner somewhat concave; finally it is sharply pointed. Its structure is simple, as may be seen in Pl. XVIII, fig. 7.

There are two *central* plates (*c.*), dorsal and ventral. Each of these is elongate

lozenge-shaped, with truncated proximal and distal angles; the proximal extremity taking part in the formation of the elbow-joint as already described, the lower joining the terminal plate (*t.*). Above the lateral obtuse angles the plate articulates with the upper external and internal marginals, and under it with the lower plates of the same name. The *upper marginal* of each side is a plate sharply folded on itself, taking part above in the elbow-joint by passing its smooth articular upper extremity under the corresponding marginal of the upper arm; it has a dorsal and a ventral edge, which articulate with the respective dorsal and ventral centrals, and a lower extremity which touches the lower marginal. Each *lower marginal* is conformed similarly to the marginals of the upper arm, being wide in the middle, narrow above and below; it is also sharply longitudinally folded on itself, and articulates with the upper marginal proximally, the central mesially, and the terminal mesially and distally.

The *terminal* forms the sharp extremity of the limb, articulating proximally with the dorsal and ventral centrals and the lower marginals. It is hollow internally, the cavity of the limb being continued into it till very nearly to its apex.

It is here to be remarked that the sharp inner edge of the forearm is often seen to be prominently denticulated in the manner shown in Pl. XVIII, fig. 7. This is the appearance which led Agassiz to establish the genus *Odontacanthus* on a fragment of a marginal plate from a forearm of *Asterolepis.*

Tail.—No remains of any tail have ever been found, but that is not remarkable, seeing that the remains occur in so disjointed a condition. I have seen one or two small and badly preserved scales from the same beds, which *might* have belonged to the tail of *Asterolepis maxima*, but of that no evidence can be adduced.

In conclusion, I may remark that the specimens figured in Pls. XV, XVI, XVII, and XVIII are all from the quarries at Kingsteps, near Nairn, and are contained in my private collection.

Postscript.—Since the preceding pages have been in type I have, after careful consideration, come to the conclusion that *Chelonichthys,* Agassiz, ought to be removed from the list of synonyms of *Asterolepis*, Eichwald. For although Agassiz records how he became convinced of their identity, and therefore withdrew his generic name in favour of Eichwald's, this seems simply to have been a mistake, as there is no proof that he ever applied the name *Chelonichthys* to any species of *Asterolepis.* The two species which he included under that name in his "Tableau général"[1] were *Ch. Asmussii* and *Ch. minor.* Of these, the former undoubtedly belongs to Asmuss's genus *Heterosteus*, while as to the latter, whatever it may be, there is no evidence for its being assigned to *Asterolepis.*

[1] 'Poiss. Foss.,' vol. i, p. xxxiii.

PTERICHTHYS, *Agassiz*, 1840.

Asterolepis, Pander (*pars*).

Generic Characters.—Pre-median plate of the head not notched in front; anterior median dorsal plate of body overlapping the anterior dorso-lateral, but overlapped by the posterior dorso-lateral. Tail covered with rounded scales, and showing a triangular dorsal and a heterocercal caudal fin. Other characters as in *Asterolepis*, but the carapace is more elevated in shape.

History.—*Pterichthys*, first discovered at Cromarty about the year 1831 by Hugh Miller, and again independently at Lethen Bar by Stables and Malcolmson in 1839, received its name from Agassiz, to whom specimens collected by Miller were transmitted for examination. The name was first published by Sir Roderick Murchison in the report of the meeting of the British Association at Glasgow in 1840, but no description appeared until 1841, when Hugh Miller gave an account of it in his "Old Red Sandstone." This description was accompanied by restored figures of both the dorsal and ventral surface of the animal, which, if neither perfect nor faultless, certainly showed that Miller had managed even at that time to attain a remarkable insight into the structure and configuration of this singular creature.

In 1844 Agassiz, in his 'Poissons fossiles du vieux grès rouge,' described the genus not only from Cromarty specimens supplied to him by Hugh Miller, but also from material from other localities, such as Lethen Bar, Clune, and Orkney, contained in the collections of Lady Gordon Cumming, Lord Enniskillen, Sir Philip Grey-Egerton, Professor Traill, and others. But it is surprising that Agassiz, in this work, seems to have paid no attention to Miller's comparatively correct description and figures, but, on the other hand, gave a most inaccurate description, in which he even mistook the ventral for the dorsal surface, while his "restoration," unfortunately copied and recopied into too many geological text-books, bore no more than a very remote resemblance to the creature it was meant to represent. Strange indeed, for one of Hugh Miller's specimens figured by Agassiz (Pl. IV, figs. 1—3) shows both dorsal and ventral surfaces as well as the head, and is, to this day, one of the most instructive examples known. To *Pterichthys* Agassiz allotted eight species, the rectification of which will be presently considered.

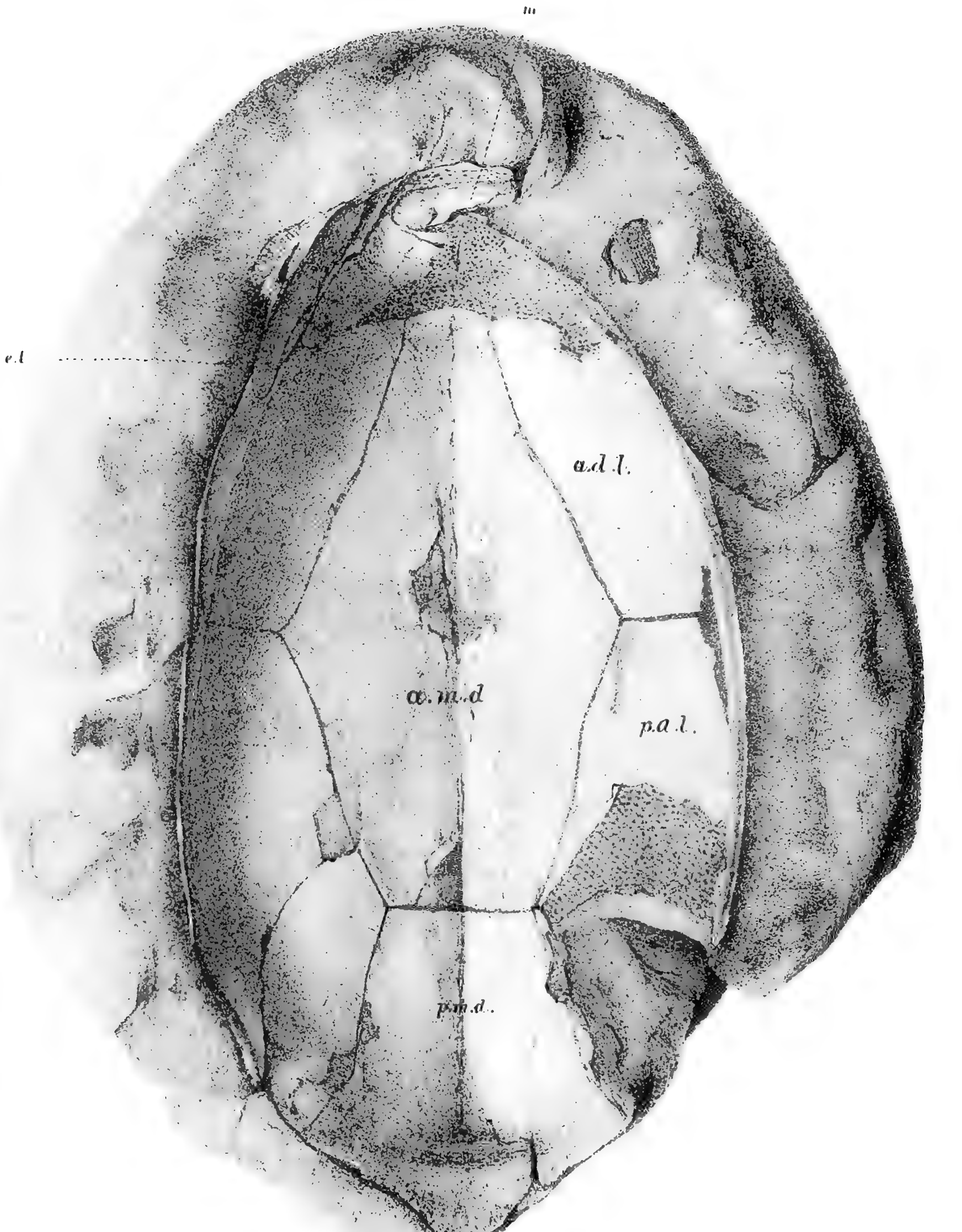
In 1848 Sir Philip Grey-Egerton published a paper on the structure of *Pterichthys*[1] containing copious extracts from letters written to him by Hugh Miller, and in which Agassiz' more glaring mistakes were rectified. Nevertheless, contrary to the more correct representation given by Miller in the "Old Red Sandstone," the front part of the anterior ventro-lateral, to which the arm is articulated, is marked off as a distinct "thoracic" plate, while the hinder

[1] 'Quart. Journ. Geol. Soc.,' vol. iv, 1848, pp. 302—314.

PLATE XV.

Dorsal portion of the carapace, with cranial shield, of *Asterolepis maxima*, Agassiz, sp., seen from the interior; one-fifth smaller than the original. This is the best specimen, with plates in apposition, which ever has been found; unfortunately the arms are wanting, and the cranial shield and posterior dorso-lateral plate are somewhat injured on the left side. The natural mould or counterpart of this specimen, not figured, gives an excellent idea of the general proportions of the creature, but the plates on the ventral surface are very badly preserved (for the letters *p. a. l.* on the shield read *p. d. l.*).

PLATE XV



Michael del. et lith.

Mintern Bros. imp.

PLATE XVI.

FIG.

1. Detached anterior median dorsal plate of *Asterolepis maxima.*

2. Posterior median dorsal plate from which the surface has flaked off behind and on the right side.

3. Right anterior dorso-lateral plate; the anterior border is not quite perfect, as it does not show the peculiar processes for articulation with the external occipital.

4. Right posterior dorso-lateral plate.

5. Median ventral plate; a small but very perfect specimen.

All these figures are of the natural size.

Fig 1

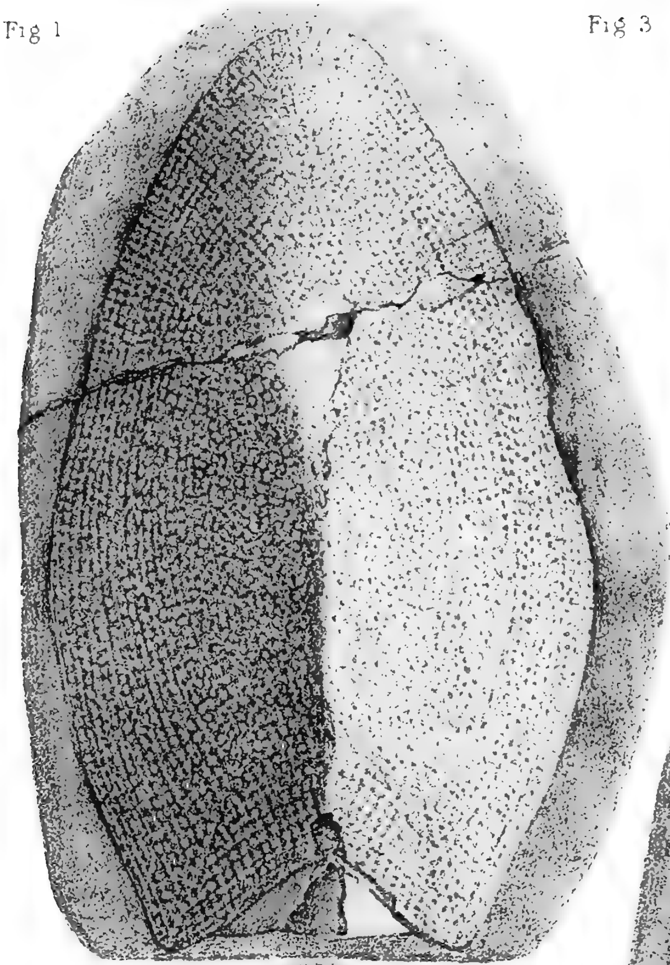
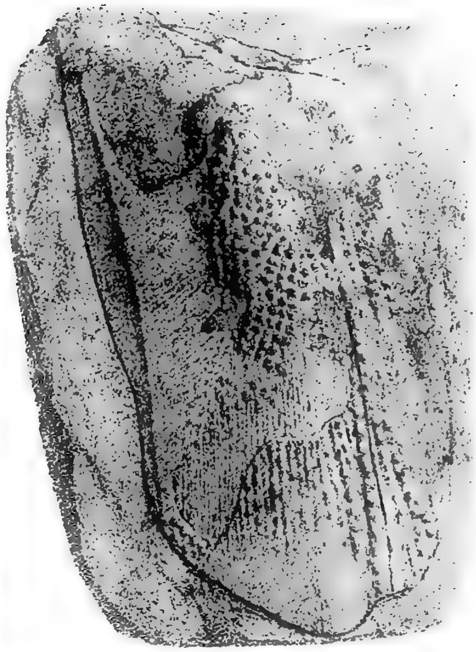


Fig 3



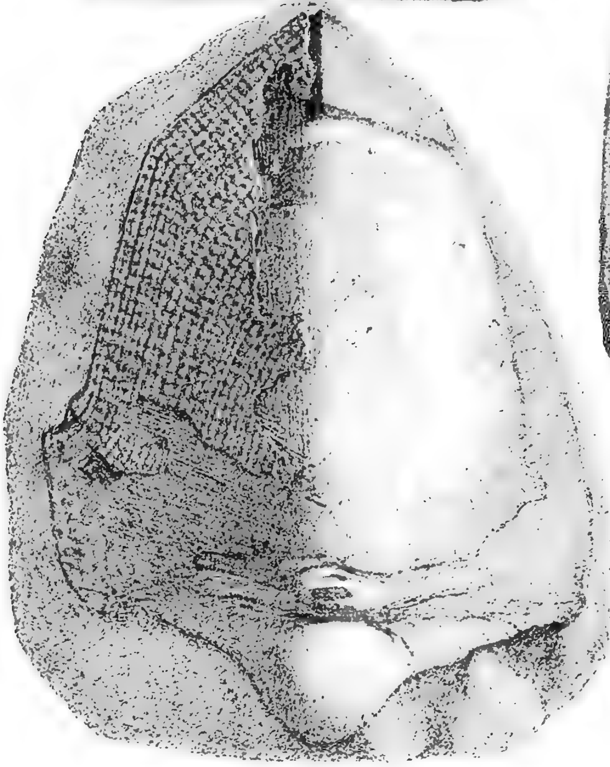


Fig 2

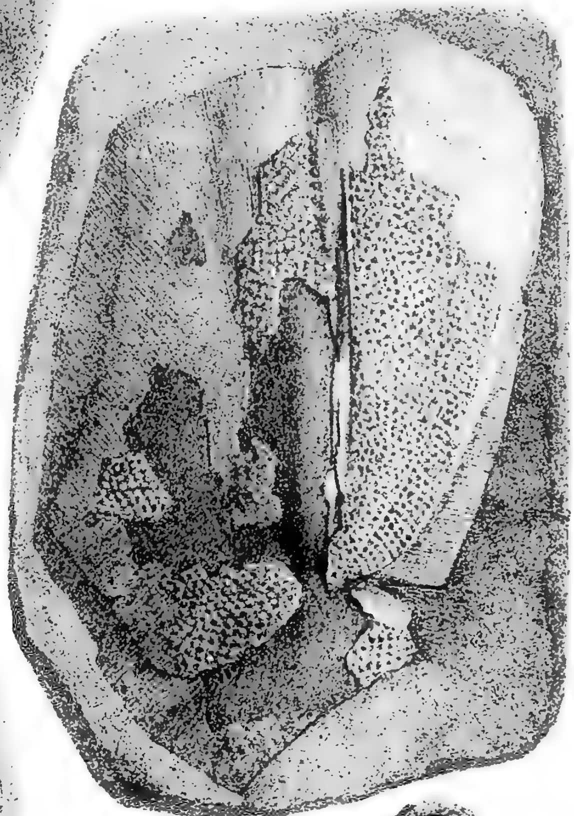


Fig 4

Fig 5

F. H Michael del et lith

Mintern Bros. imp

PLATE XVII.

Fig.

1. Cranial shield of *Asterolepis maxima* without the extra-lateral plates, and somewhat injured behind the orbit (the letters *eg*. should be *ag*.).

2. Median ventral plate.

3. Natural cast or impression of the deep surface of the left anterior ventro-lateral plate.

4. The same specimen from the lateral aspect, showing impression of the ascending lamina.

5. Natural cast or impression of the deep surface of the left posterior ventro-lateral plate.

6. The same specimen seen from the outer side, showing impression of the ascending lamina.

All these figures are of the natural size.

PLATE XVII.

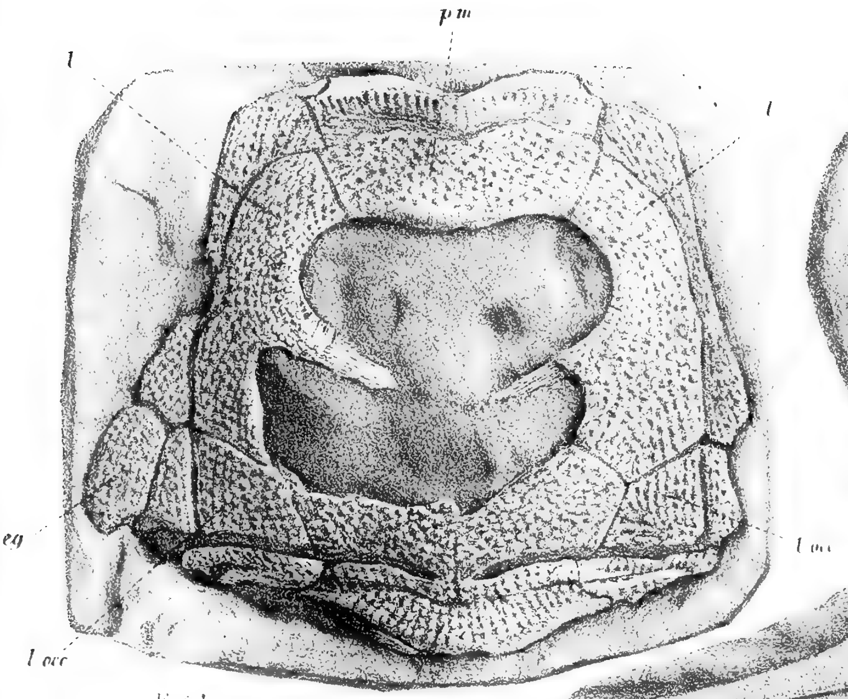


Fig. 1

Fig. 2

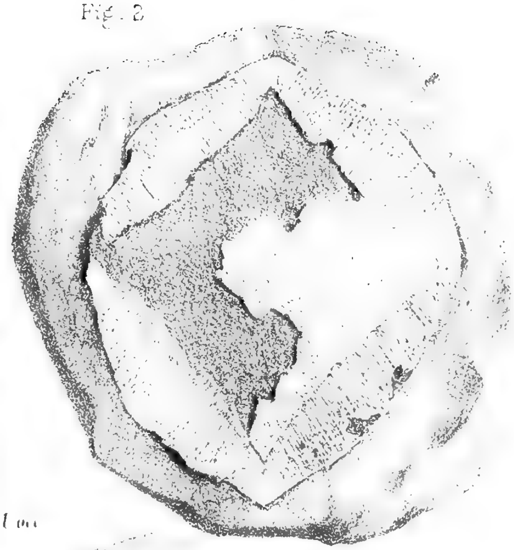


Fig. 6

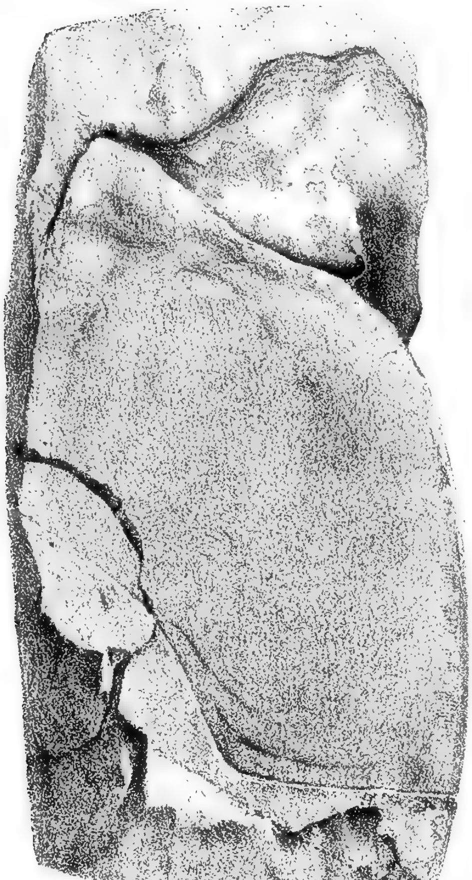


Fig. 3

Fig. 4

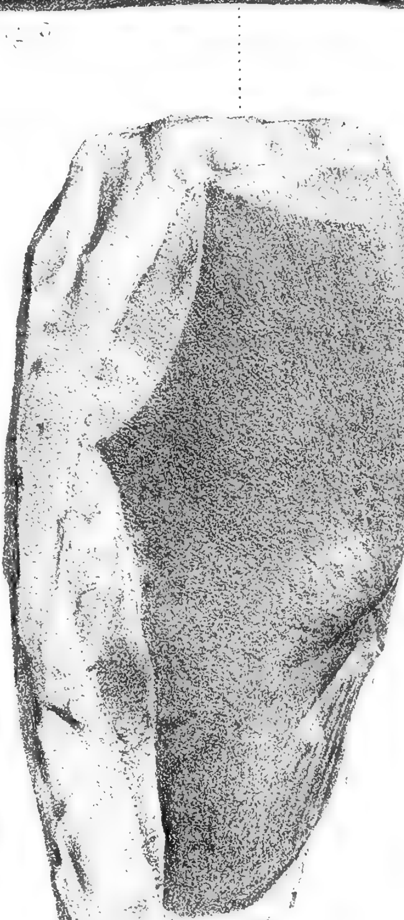


Fig. 5

F.H. Michael del et lith.

Mintern Bros. imp.

PLATE XVIII.

FIG.

1. Impression of the dorsal surface of the left pectoral appendage of *Asterolepis maxima*, with a portion of the anterior ventro-lateral plate. The point of the lower arm is gone.

2. Natural mould of the internal cavity of the arm removed from the same specimen, and seen from the dorsal surface, showing very distinctly the impressions of the deep surfaces of the constituent plates, and of the sutures between them; unfortunately wanting the point, and fractured across below the joint.

3. The same, seen from the ventral surface.

4. Ventral surface of the proximal division of the limb of the right side, broken off immediately above the elbow-joint, and retaining most of the actual bone.

5. The same specimen seen from the outer aspect.

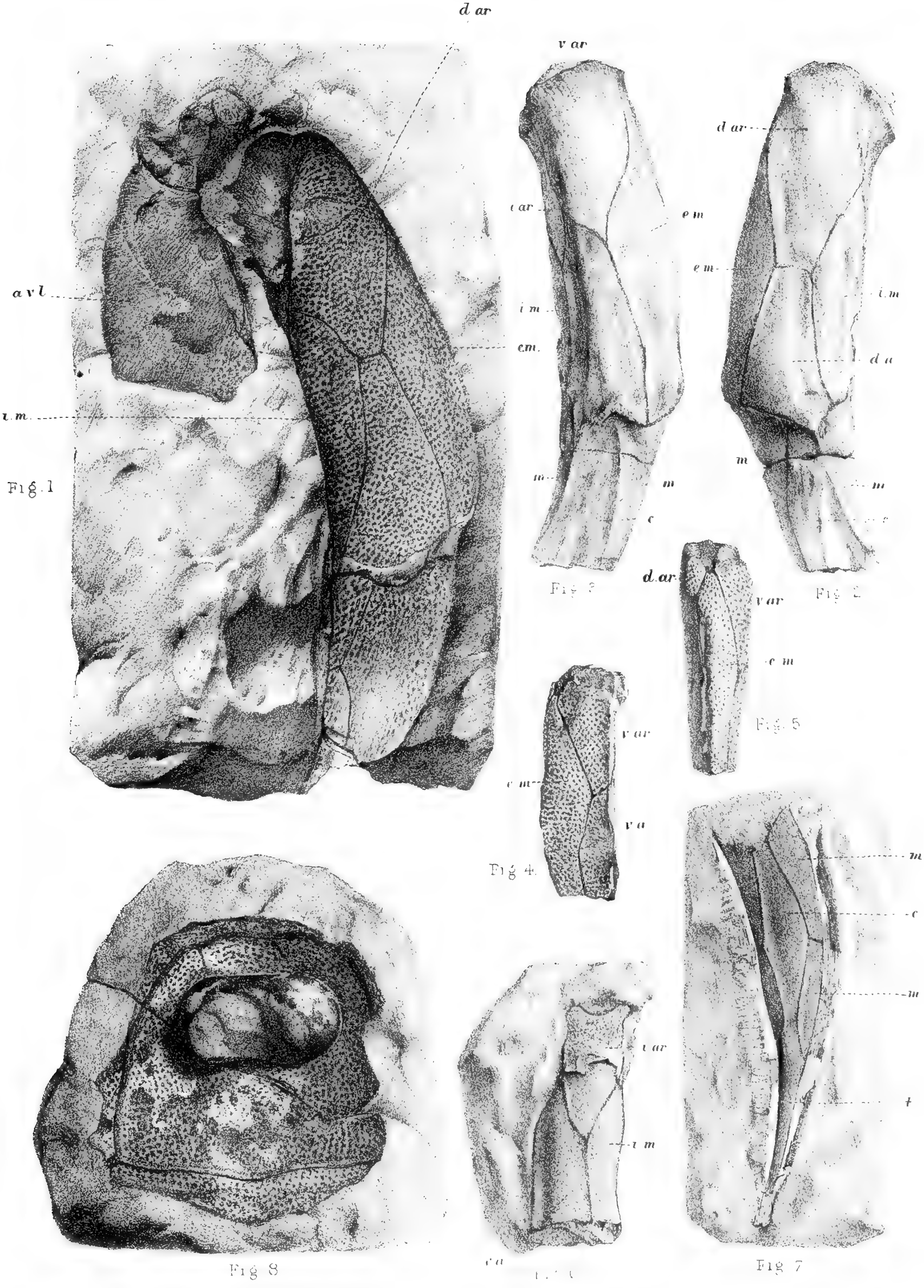
6. Part of the right upper arm seen from the inner aspect, to show the internal articular plate. The two articulars are wanting, and the anconeal and internal marginal, seen in impression, are broken off below.

7. Dorsal surface of the right lower arm, or distal joint of the limb. Most of the bone has flaked off, leaving impressions of the plates and of their dividing sutures.

8. Impression of the external surface of a head, with natural mould of the interior of the orbital cavity.

All these figures are of the natural size.

PLATE XVIII.



F.H. Michael del et lith.

Mintern Bros. imp.